NET ZERO HOUSING

A Machine with a Poetic Bias

Ana Paola Hernandez | December 13, 2021

1.2 - City Walk

“Two generations of luxury apartment houses confront each other diagonally across an intersection, and a comparison is telling. No. 740 is another of the buildings by Rosario Candela, architect of 834 Fifth Avenue, and it is in many ways his best - a solid, sumptuous mass that sits on a corner with absolute authority. The building is sheathed entirely in limestone, and a fluted base and entrance details suggest a hint of Art Deco.....

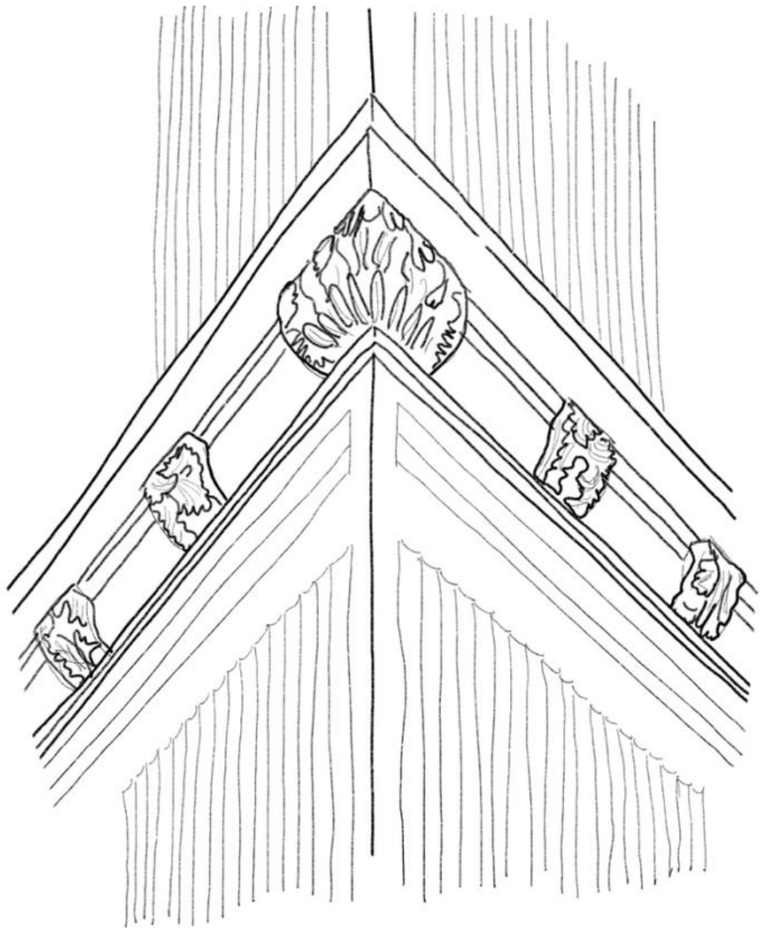
No such Roman affectations across the street. No. 733 Park was an attempt to construct an apartment house in the grand manner of buildings of a generation previous, such as No. 740, but it is nothing but a tower of red brick.”

The City Observed : New York, Paul Goldberger

1.2 - City Walk

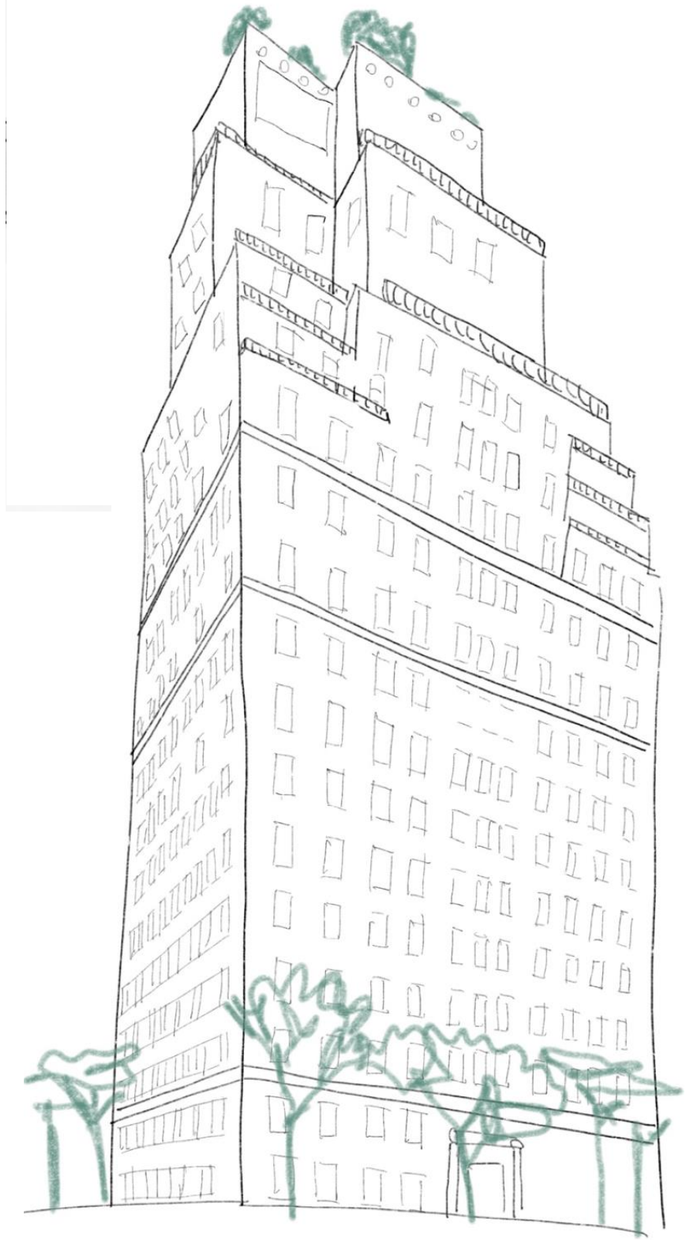
1.2.1 Scenic Sketches - 740 Park Avenue

740 Park Avenue:
Scenic Sketches



Corner Detail

Street Base at Entry Door



View from Park Avenue
and East 71 Sreet

1.2 - City Walk

1.2.2 Documentation - 733 Park Avenue

733 Park Avenue:
General Information

Architects:

Ely Jacques Kahn and Robert Allen Jacobs

Builders:

Alexander Muss and Charles Rosenberg

Technical Data:

Height: 299 ft
Floors: 30
Apartment Units: 28, Co-op
Construction Start - End: 1969 - 1971

Firm's History:

The firm Khan and Jacobs was formed in 1940. Jacob was the son of architect Harry Allen Jacobs and graduated from Columbia University's architecture school in 1934. Between 1934-35 he worked as a designer an draftsman for Le Corbusier in Paris. In 1935 he returned to New York and became a designer for Harrison and Fouilhoux Architects, and in 1938 he joined Jacobs Kahn's firm and became a partner in 1940.

The firm worked on a wide range of project types, including commercial, industrial, institutional buildings, airports, and housing. Drawing from European influences, they were leaders among American architects. Kahn's modernism before WW2 was of the Art Deco-Modern variety, while Jacob's modernism was very much a product of his influence by Le Corbusier.

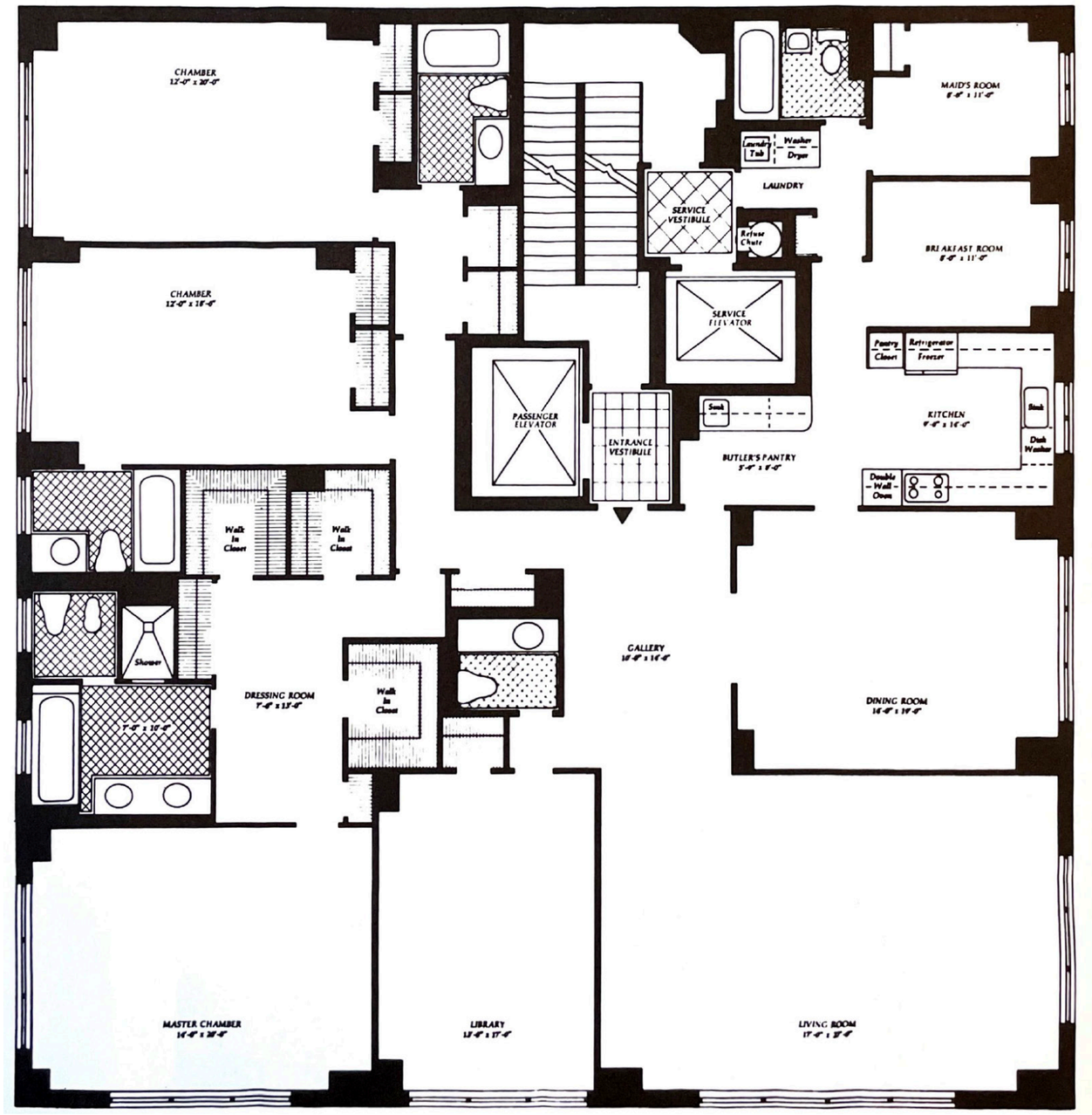
Building's History:

733 Park Avenue represented a style of luxurious upscale urban living that has today disappeared from the city. The new 30-story tower replaced the red brick, English Regency-style mansion built in 1904 by Carrere & Hastings for senator Elihu Root. The Landmarks Preservation Commission had tried to save the house; however, without success, the 30-room mansion was put up for sale by Mrs.Carll Tucker, who had lived there since 1915.

The building is setback from the edge of the lot, interrupting Park Avenue's continuous solid wall of buildings. 733 Park Avenue and 900 Park Avenue were the only two towers at the time that soared above the rest, which averaged about 15 stories. The architects decided to set back the tower to prevent the new building from disrupting the famous avenue's look. This setback created a small landscape plaza, today designated as a Privately Owned Public Space (POPS).

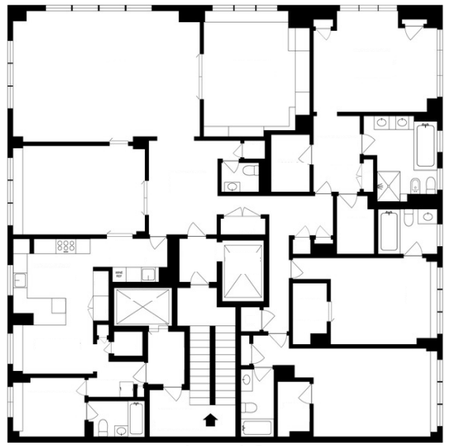
733 Park Avenue has been described by many as a "bland" apartment building with a granite base and simple dark brown bricks above. In a 1979 article from The New York Times, "Top Postwar Apartment Buildings," Paul Goldberger described 733 Park Avenue as having an "ordinary outside but a very distinguished inside" and while "not River House, it probably comes closer to recreating the grand apartment houses of an earlier era than anything else Park Avenue has seen in decades." The 30-story building contained only 28 full-floor apartments. Each typical unit consisted of 9 rooms and 4.5 bathrooms. The duplex penthouse consistent of 9 rooms more generously spaced out. The 8ft 11in floor-to-ceiling heights were higher than average for its time but not impressive. Each apartment was served by both a passenger and servant elevator.

733 Park Avenue:
Original Typical Floor Plan



N

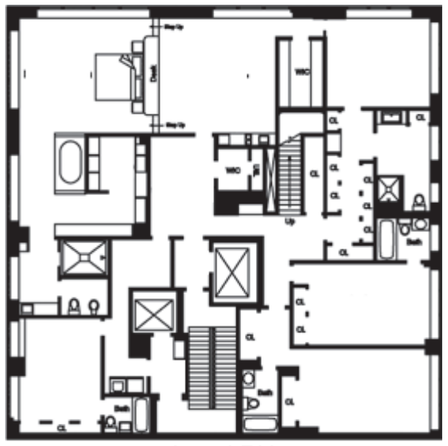
733 Park Avenue:
Current Floor Plans


Level 2


Level 5


Level 11


Level 20


Level PH

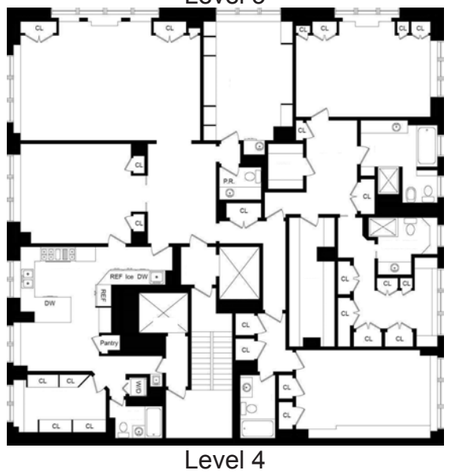

Level 3


Level 6

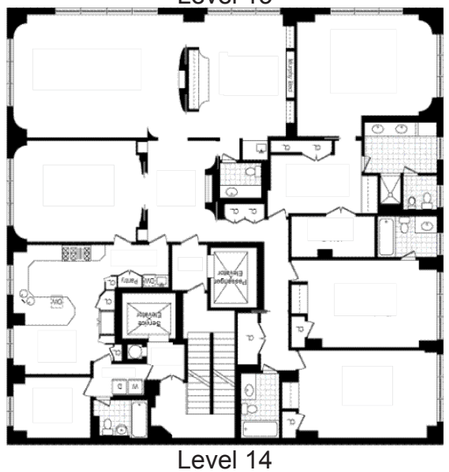

Level 13


Level 22

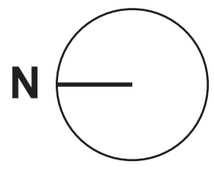

Level PH


Level 4


Level 10


Level 14


Level 26



733 Park Avenue:
Photographic Documentation

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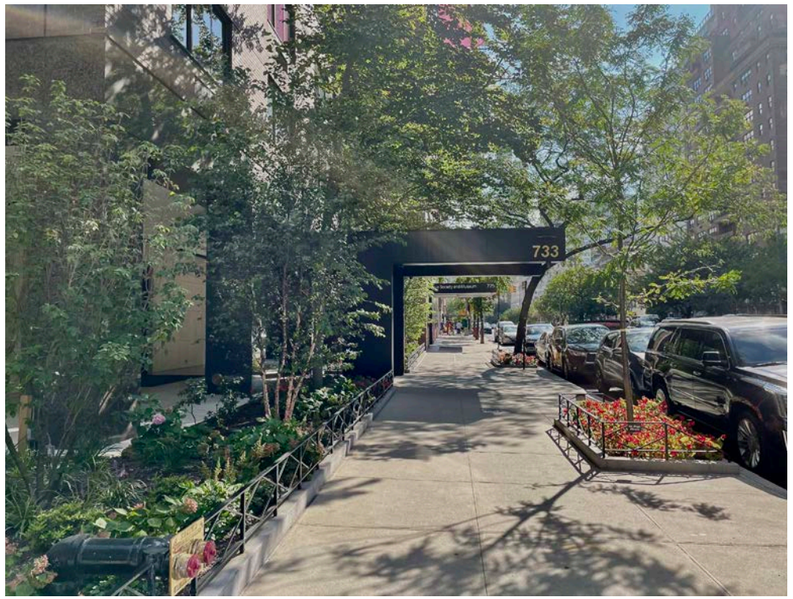
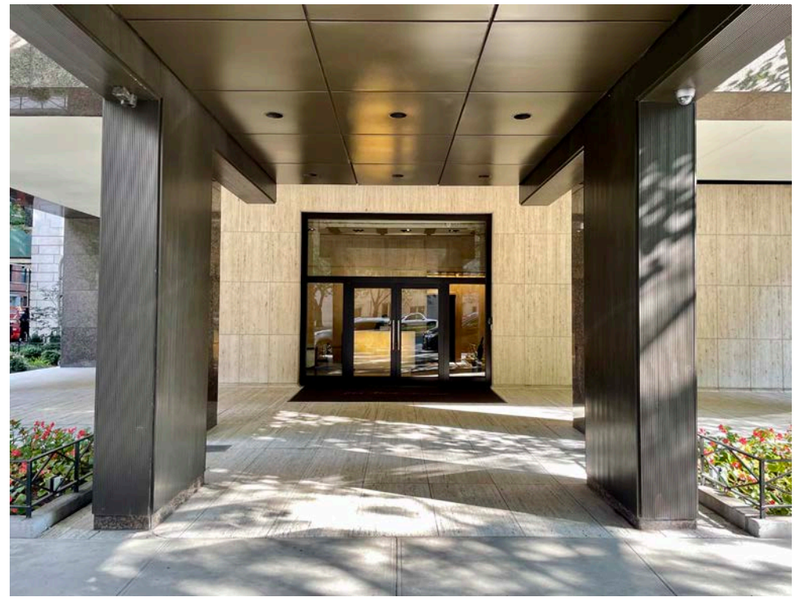
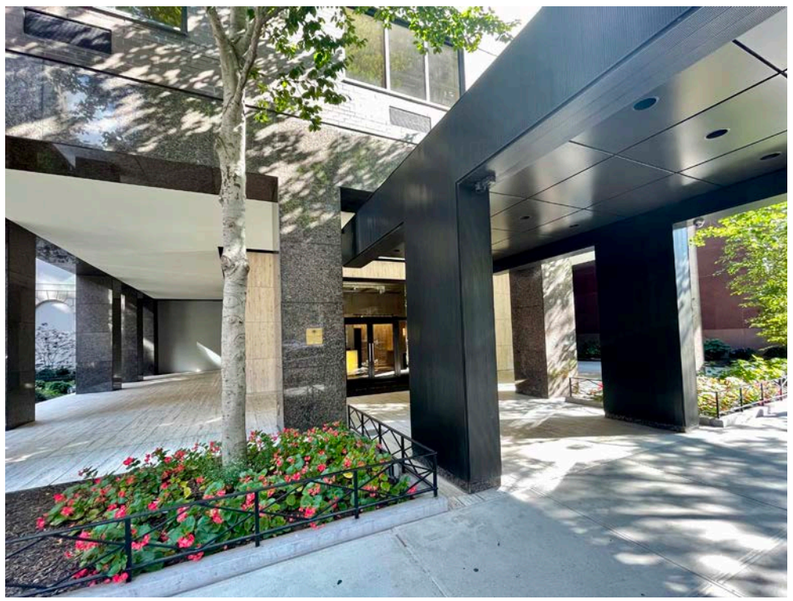
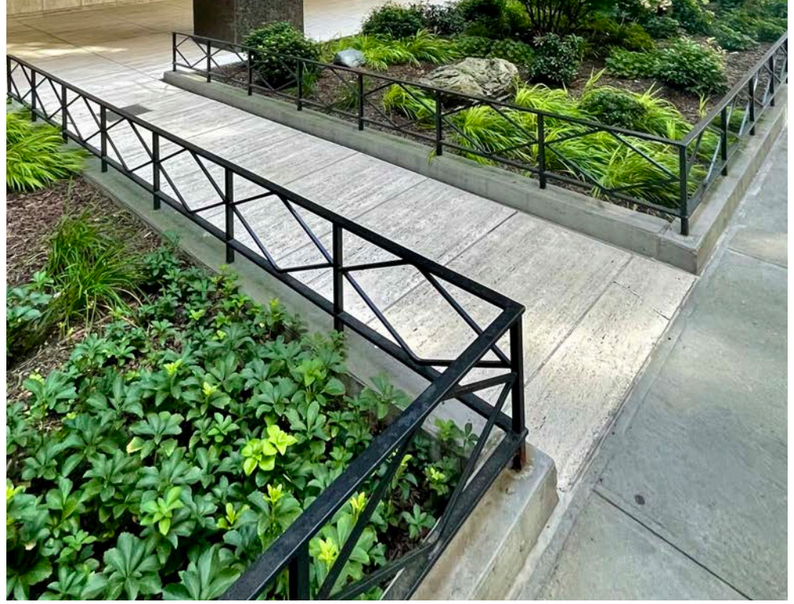
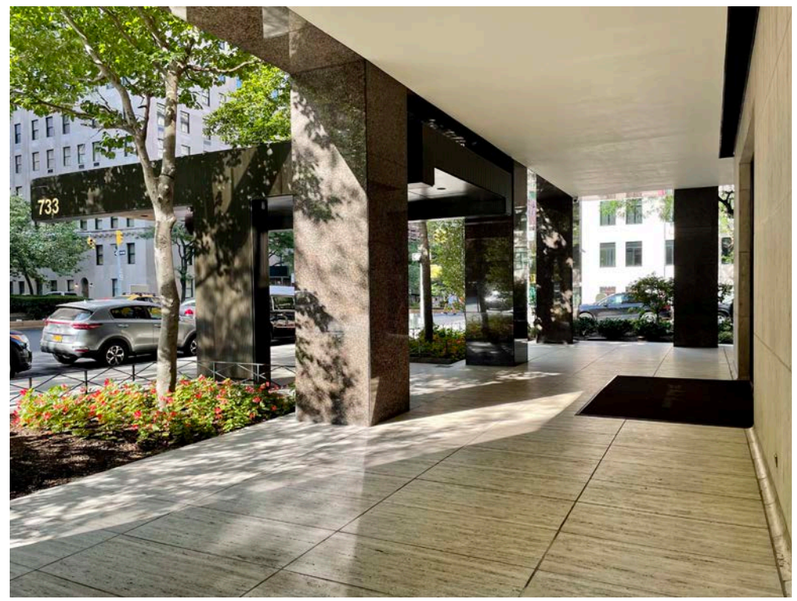
Photographic Documentation



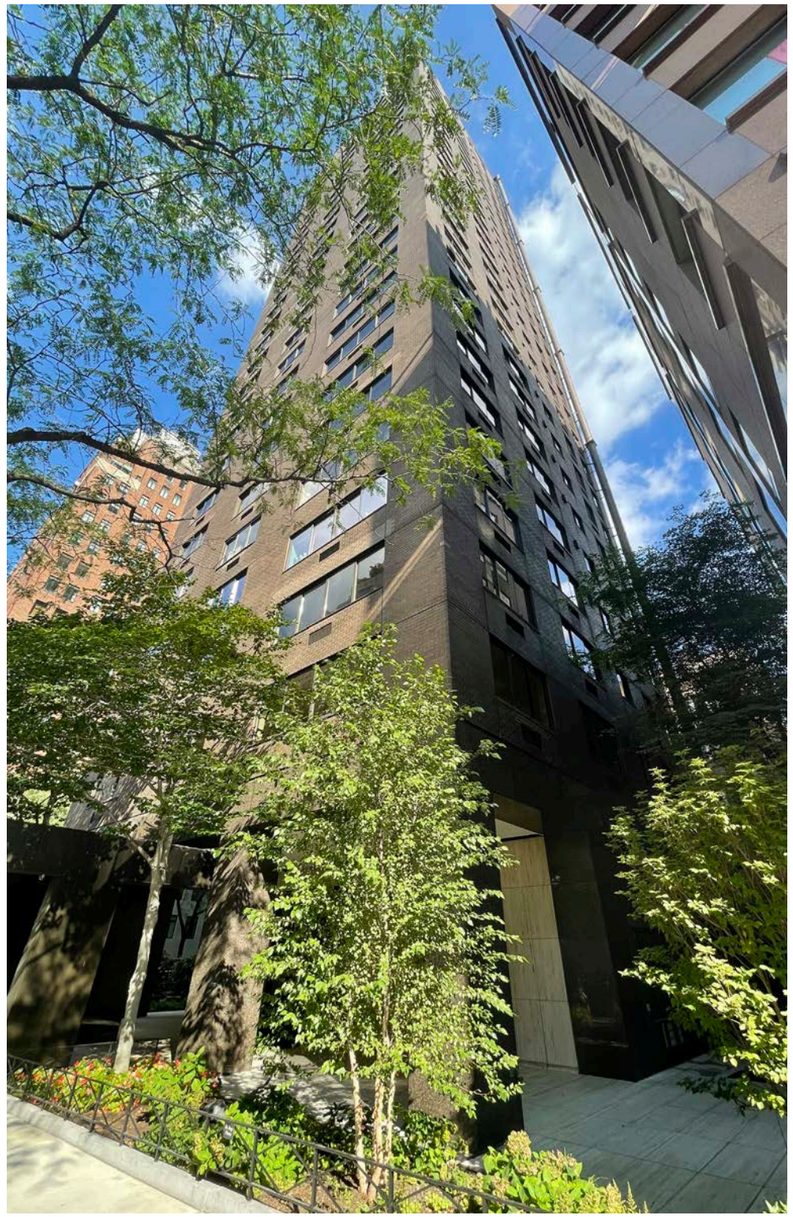


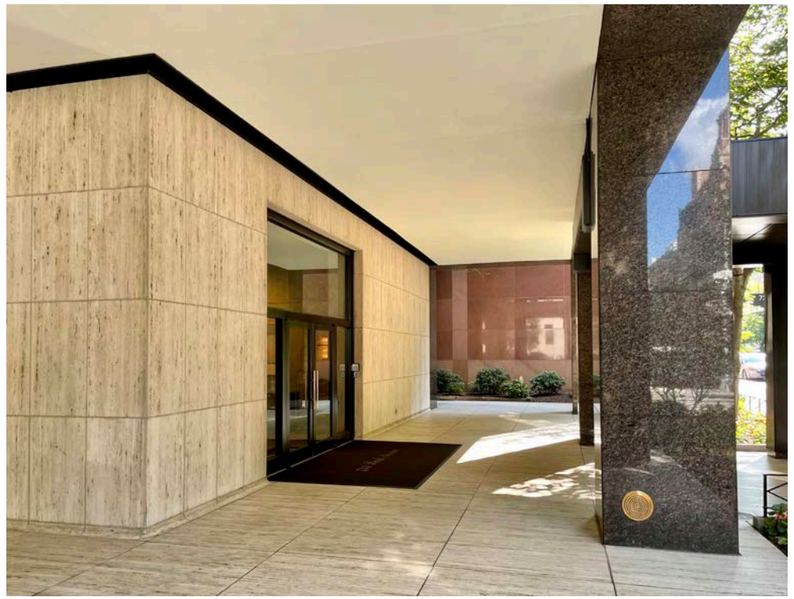


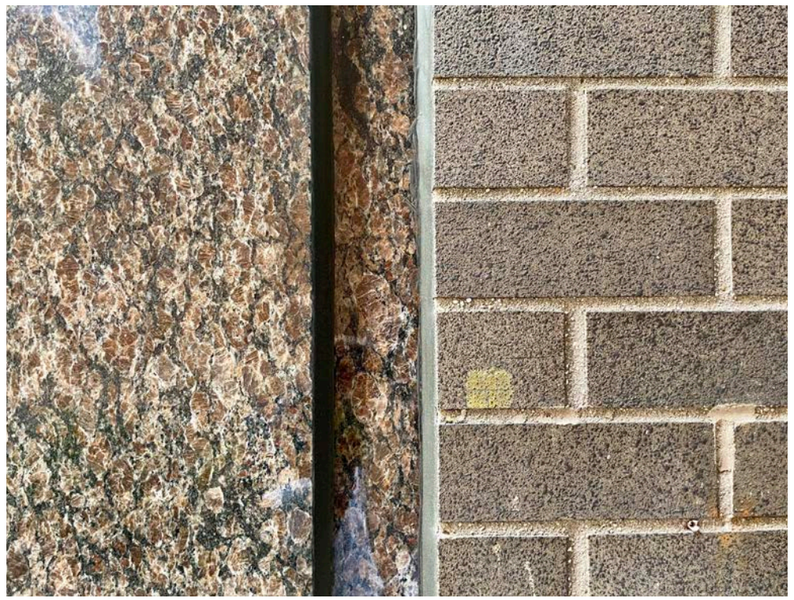


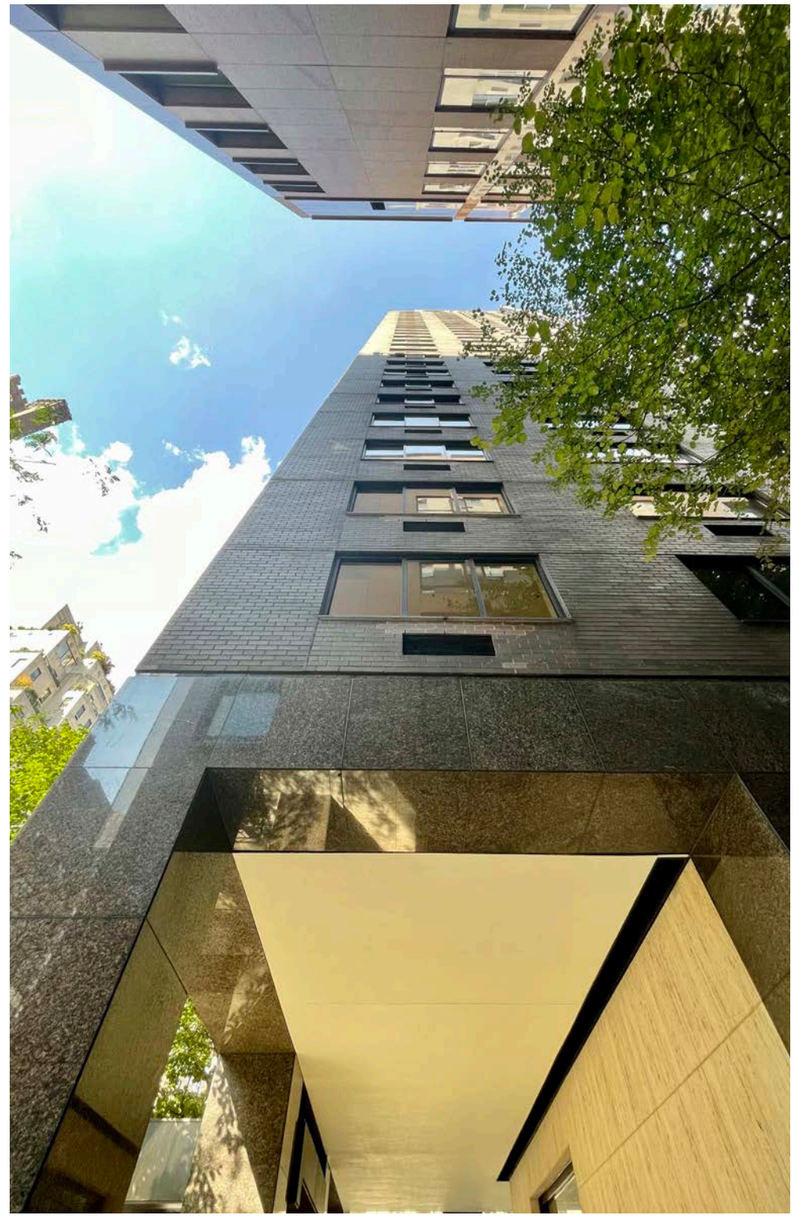


733 Park Avenue:
Photographic Documentation

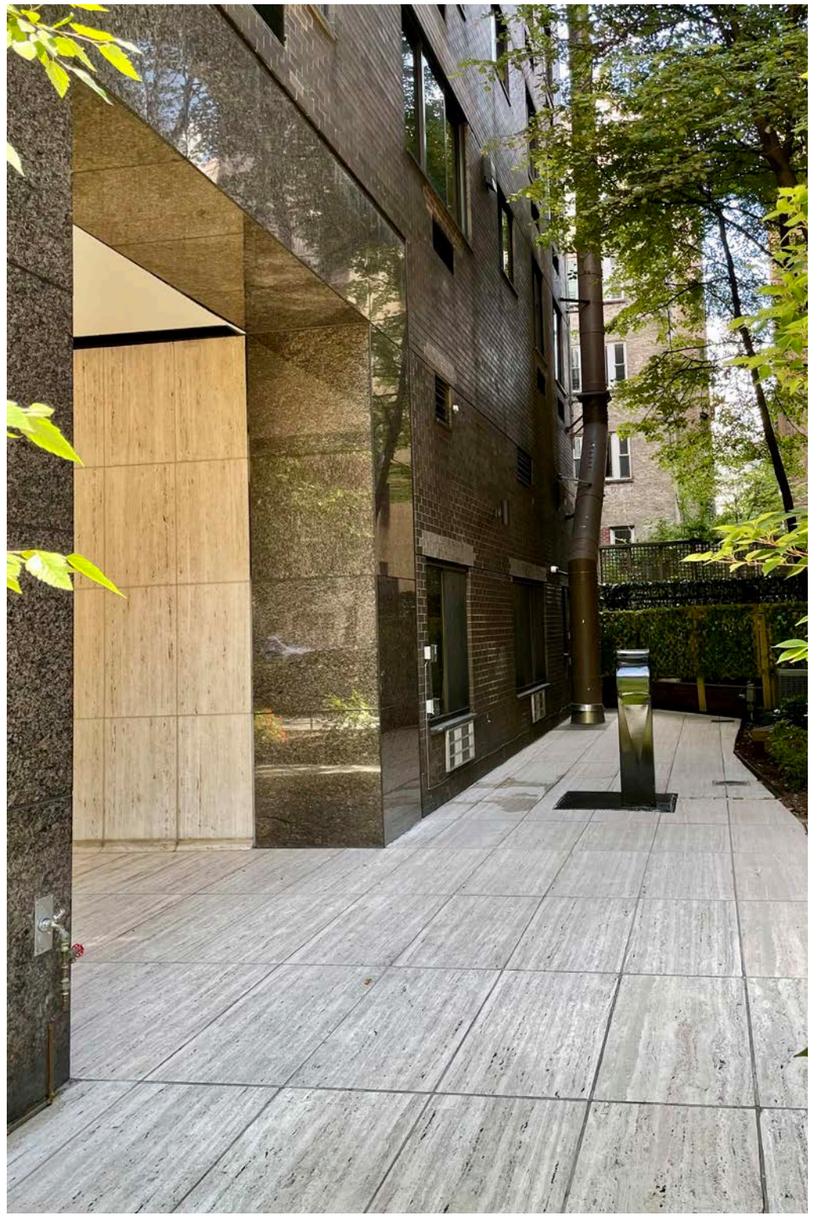


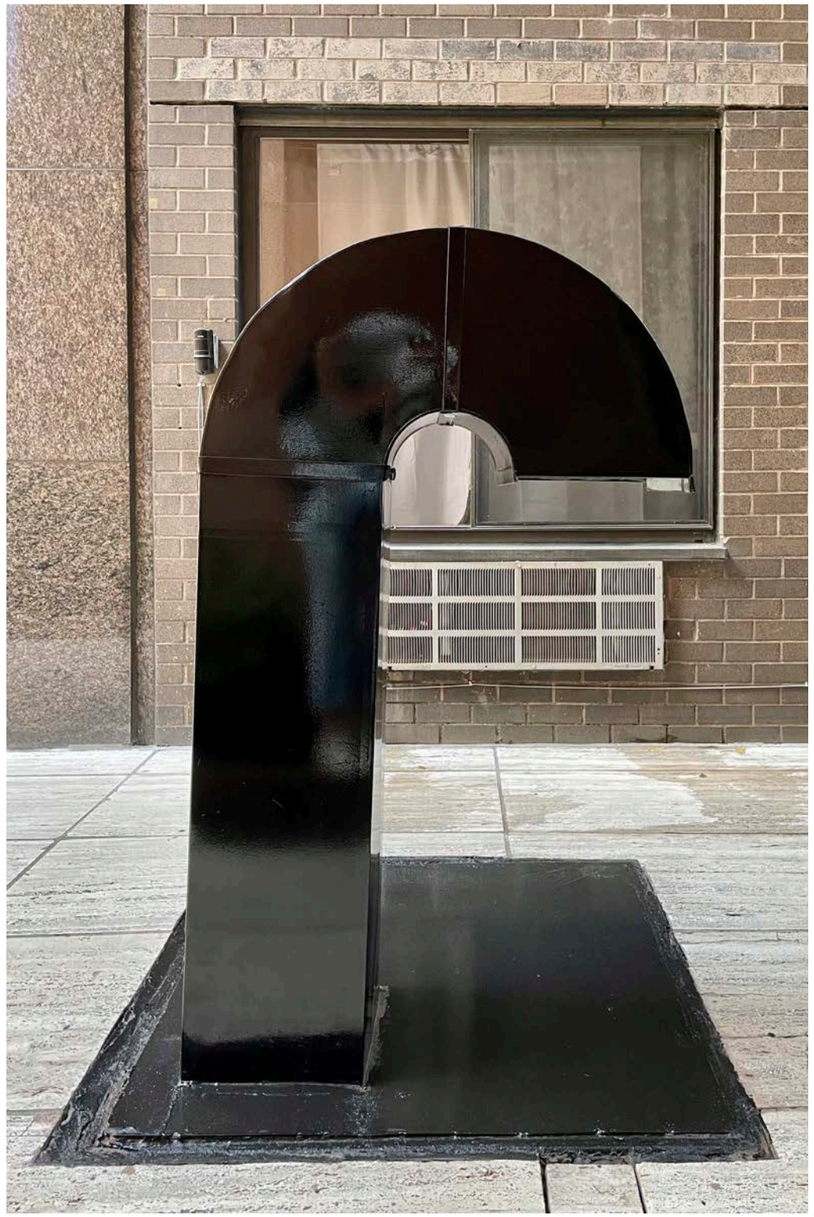






733 Park Avenue:
Photographic Documentation





1.2 - Living Room

“...the wall of a house has many of the same functions as a shutter - to keep out storm winds or excess heat - and yet we are unlikely to appreciate a wall for those particular functions because it does not go through any changes that would draw our attention to its performance.”

Thermal Delight in Architecture, Lisa Heschong

1.2 - Living Room

2.2.1 Interior Rendering

733 Park Avenue:
Living Room - Original Design

N

733 Park Avenue:
Living Room - New Design

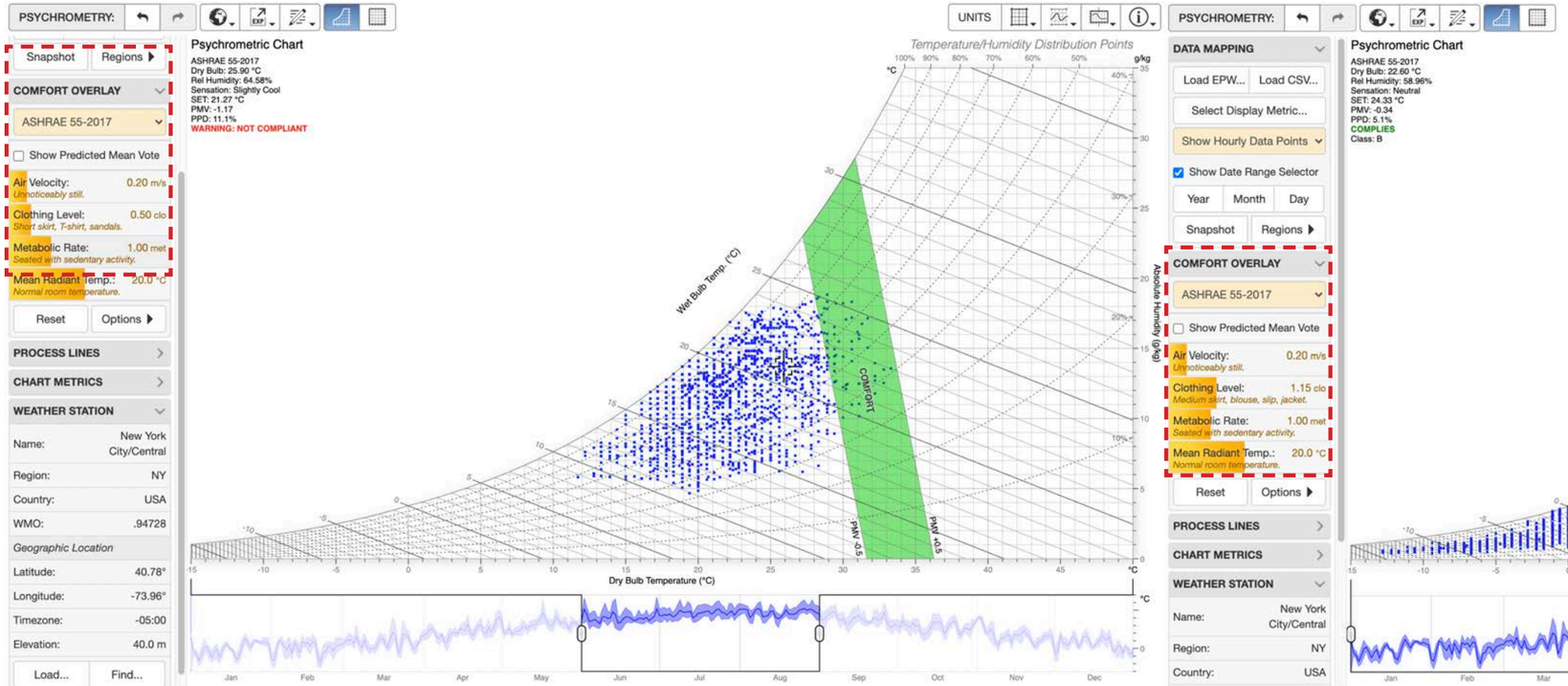
N

1.2 - Living Room

2.2.2 Thermal Comfort Analysis

733 Park Avenue:
New York City - Psychrometric Chart

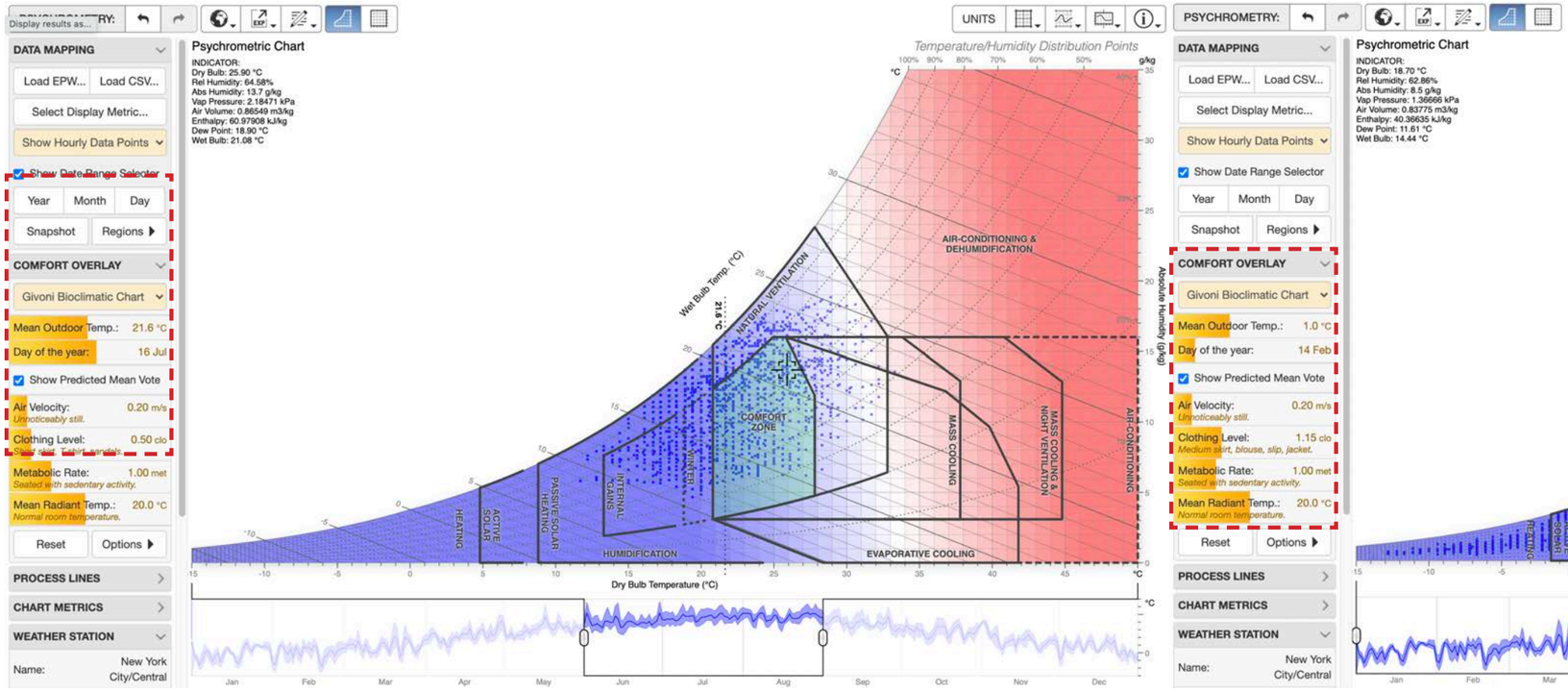
Summer



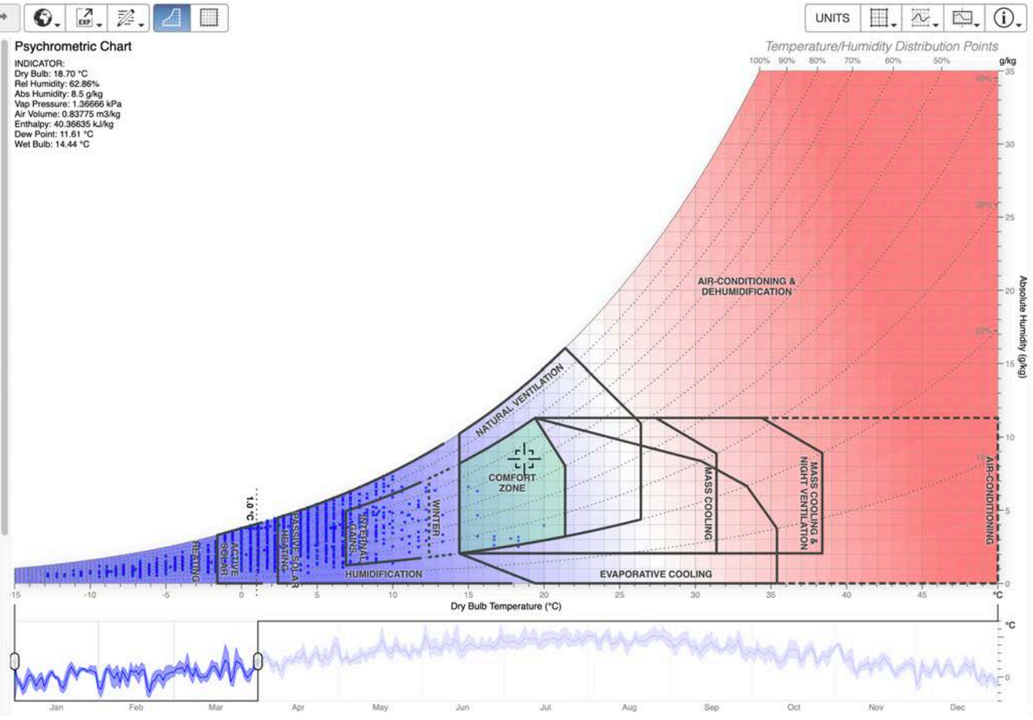
Winter

733 Park Avenue:
New York City - Psychrometric Chart

Summer

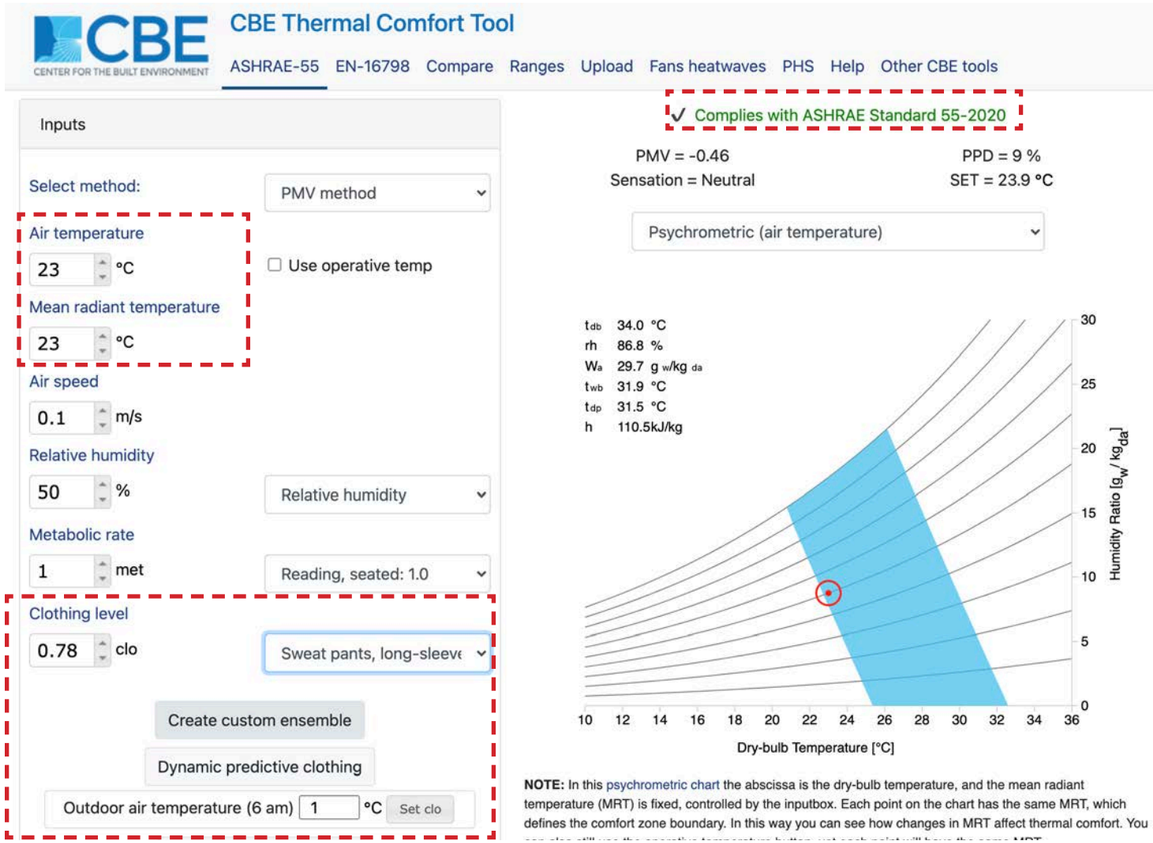


Winter

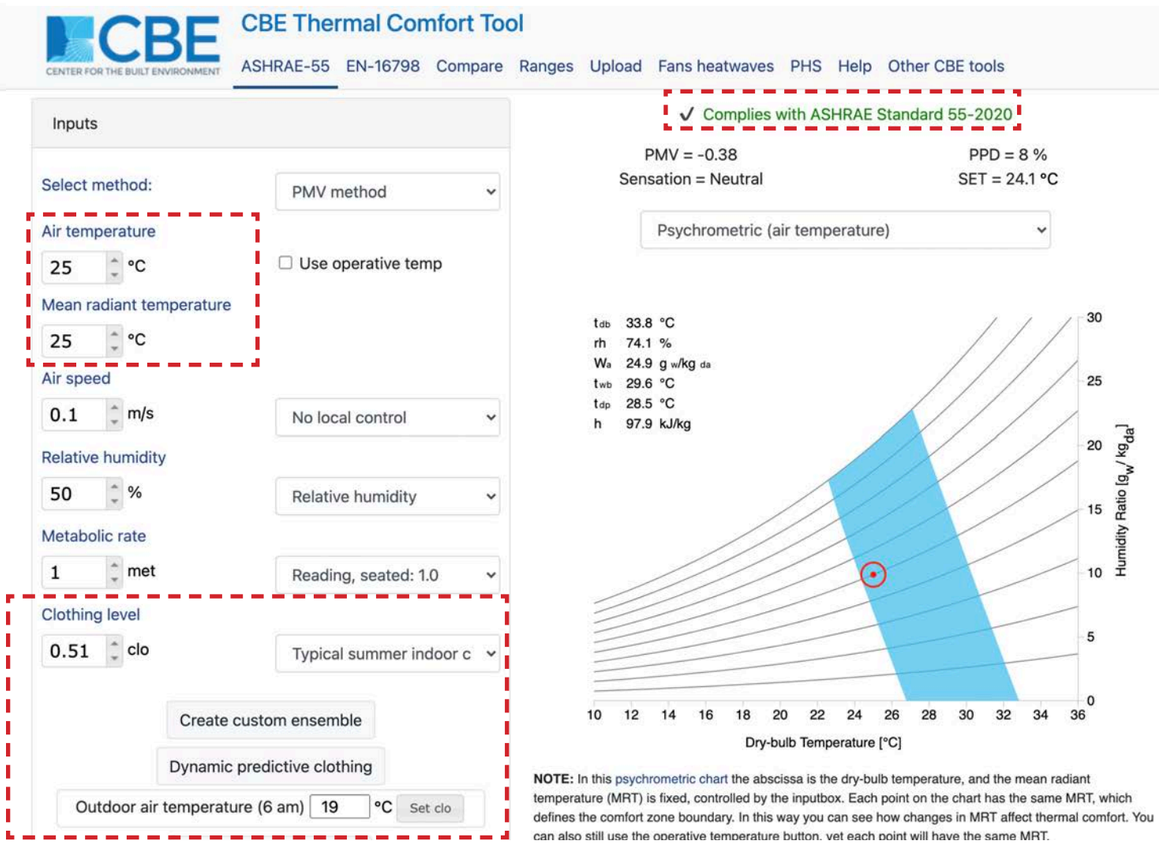


733 Park Avenue:
CBE Thermal Comfort

Summer

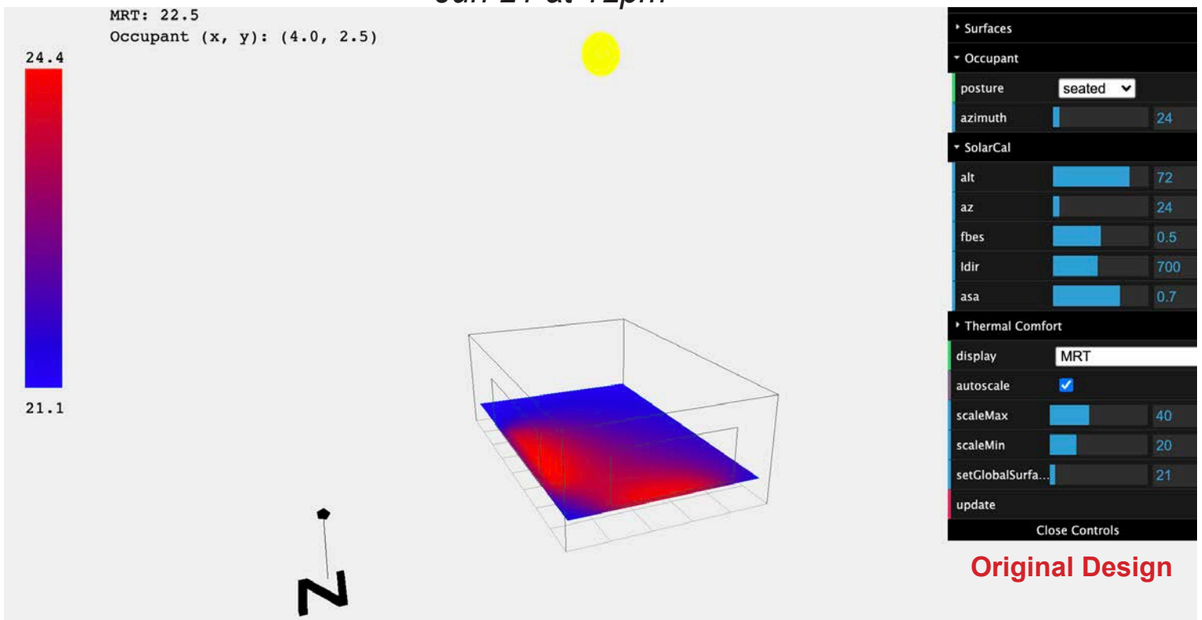


Winter



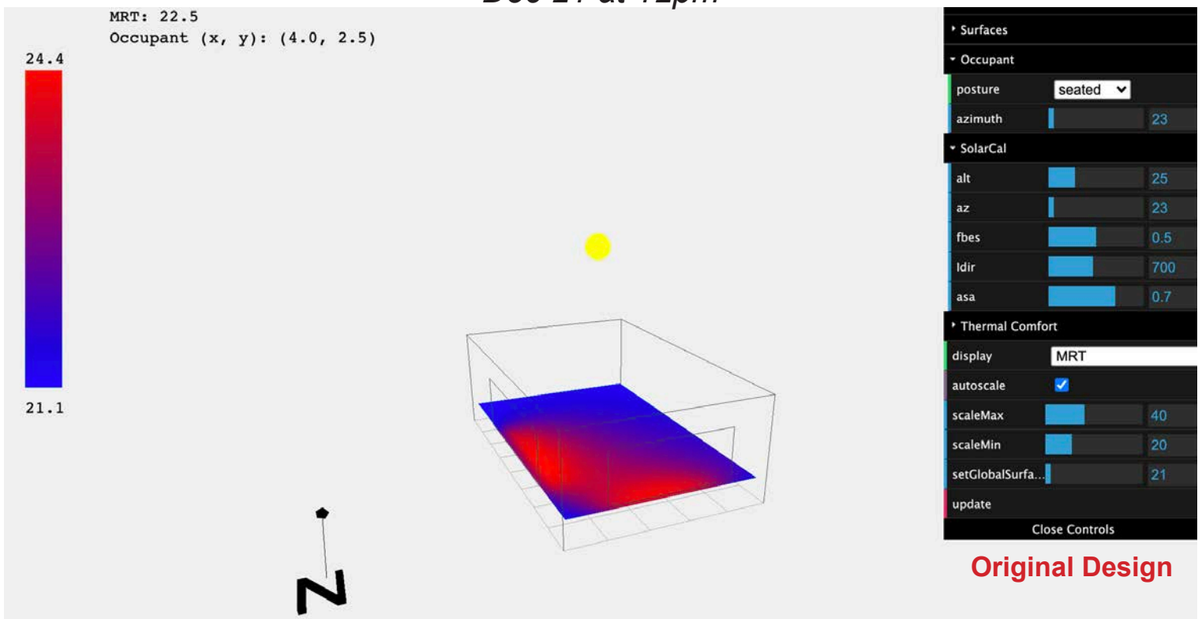
733 Park Avenue:
CBE MRT Calculator

Summer
Jun 21 at 12pm

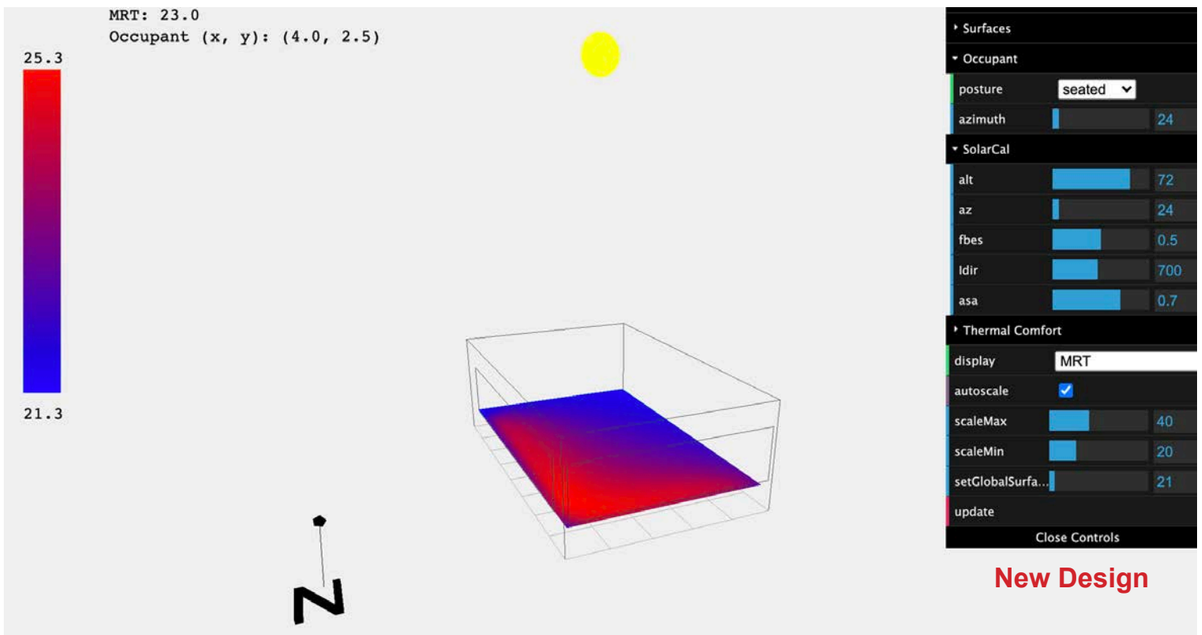


Original Design

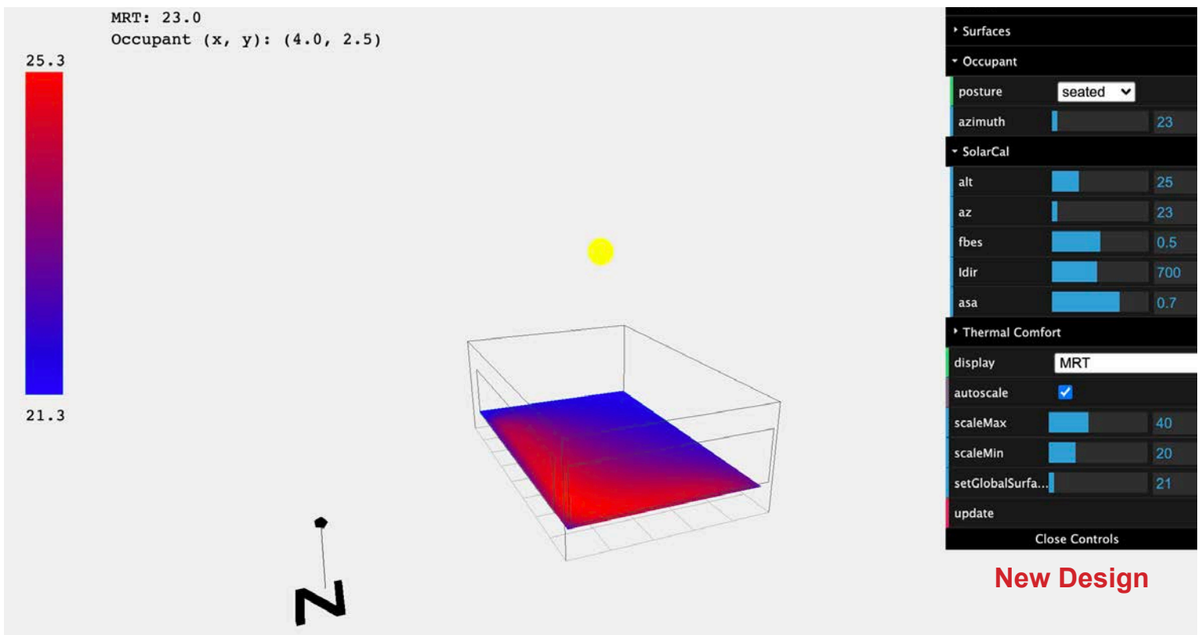
Winter
Dec 21 at 12pm



Original Design



New Design



New Design

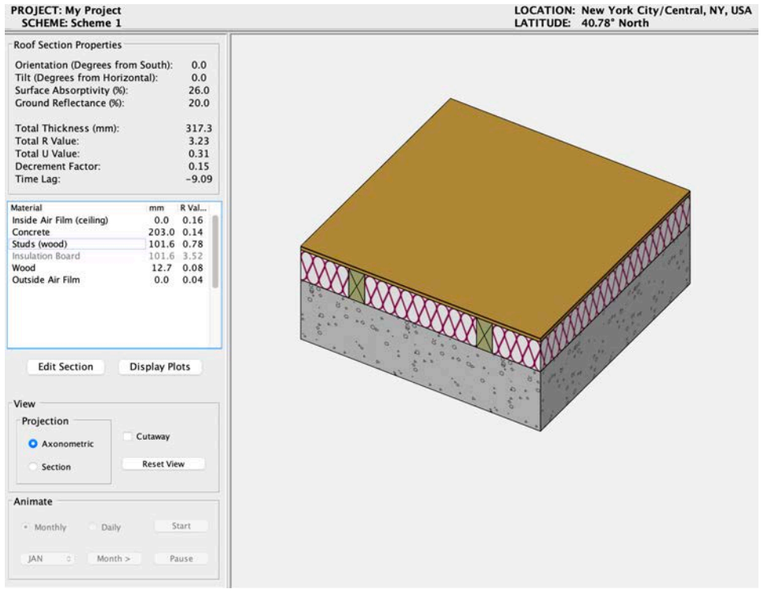
4.2 - Model with Urban Context

The R-value is a measure of how well a two-dimensional barrier, such as a layer of insulation, a wall or ceiling, resists the conductive flow of heat. R-value is the temperature difference per unit of heat flux needed to sustain one unit of heat flux between the warmer surface and colder surface of a barrier under steady-state conditions.

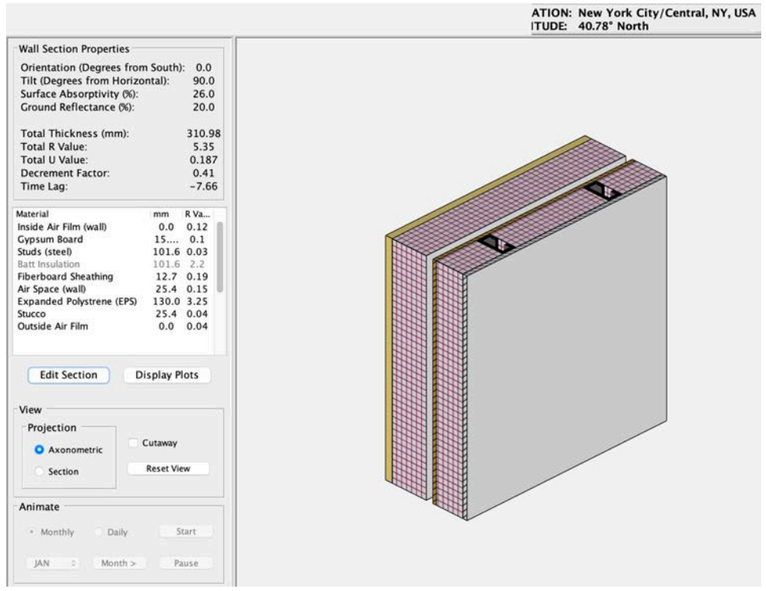
733 Park Avenue:
Context Model

733 Park Avenue:
Floor, Wall and Ceiling Assemblies

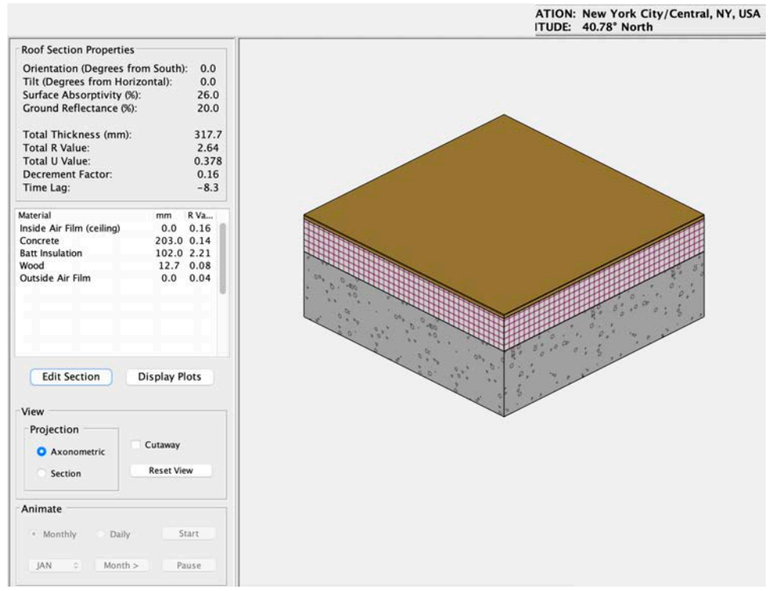
Floor Assembly



Wall Assembly



Roof Assembly



733 Park Avenue:
Assembly U-Values

▼ Assemblies (default)

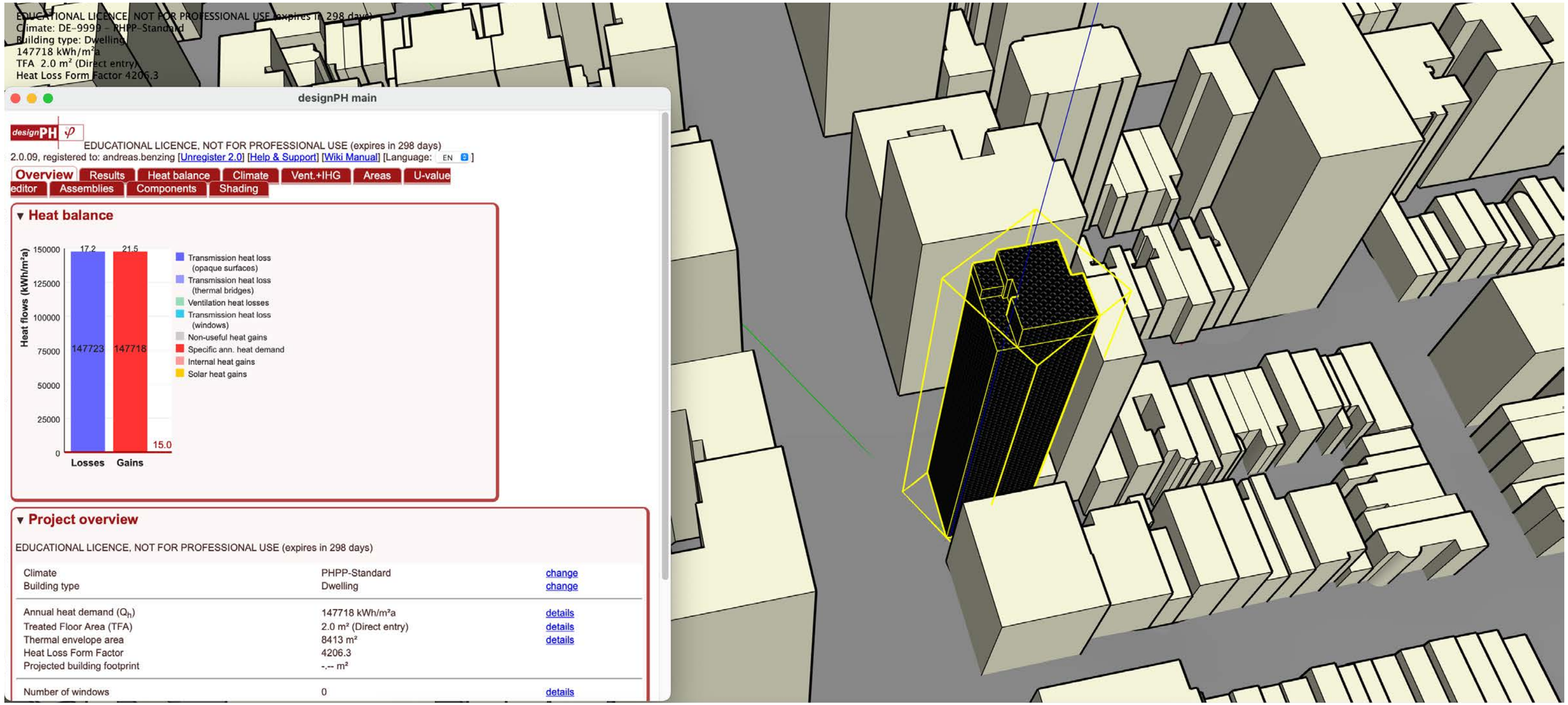
Grp. no.	Area group	Assembly no.	Assembly name	Total thickness (m)	U-value (W/m^{2}K)
7	External Door	89ud	external_door	0.05	0.50
8	External Wall - Ambient	83ud	PH external wall	0.46	0.15
9	External Wall - Ground	86ud	PH basement wall	0.41	0.25
10	Roof/Ceiling - Ambient	84ud	PH roof	0.46	0.15
11	Floor slab / Basement ceiling	85ud	PH floor	0.41	0.25
14	Temperature zone X	88ud	Wall to zone X	0.46	0.15
18	Partition Wall to Neighbour	87ud	wall_neighbour	0.41	0.25

▼ Assemblies (user-defined)

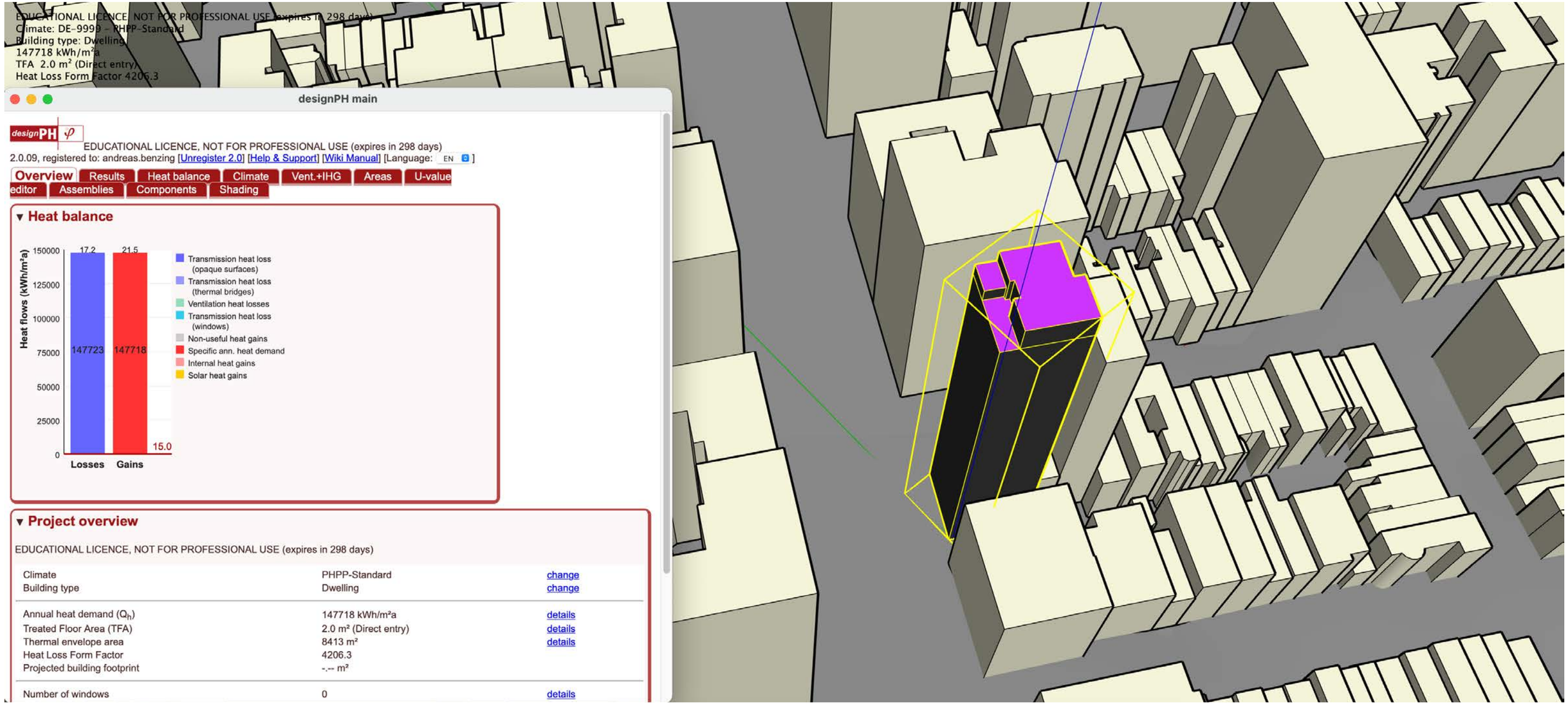
ID	Assembly name	Total thickness	U-value (W/m^{2}K)	Internal insulation?
83ud	PH external wall	0.46	0.15	☐
84ud	PH roof	0.46	0.15	☐
85ud	PH floor	0.41	0.25	☐
86ud	PH basement wall	0.41	0.25	☐
87ud	wall_neighbour	0.41	0.25	☐
88ud	Wall to zone X	0.46	0.15	☐
89ud	external_door	0.05	0.5	☐
90ud	733_Exterior Wall	0.302	0.187	☐
91ud	733_Roof	0.317	0.378	☐
92ud	733_Floor	0.317	0.31	☐
93ud		0.0	0.0	☐
94ud		0.0	0.0	☐
95ud		0.0	0.0	☐
96ud		0.0	0.0	☐
97ud		0.0	0.0	☐
98ud		0.0	0.0	☐
99ud		0.0	0.0	☐

↑ show less... (hide last 10 rows) ↑

733 Park Avenue:
Design PH Context Model



733 Park Avenue:
Design PH Context Model

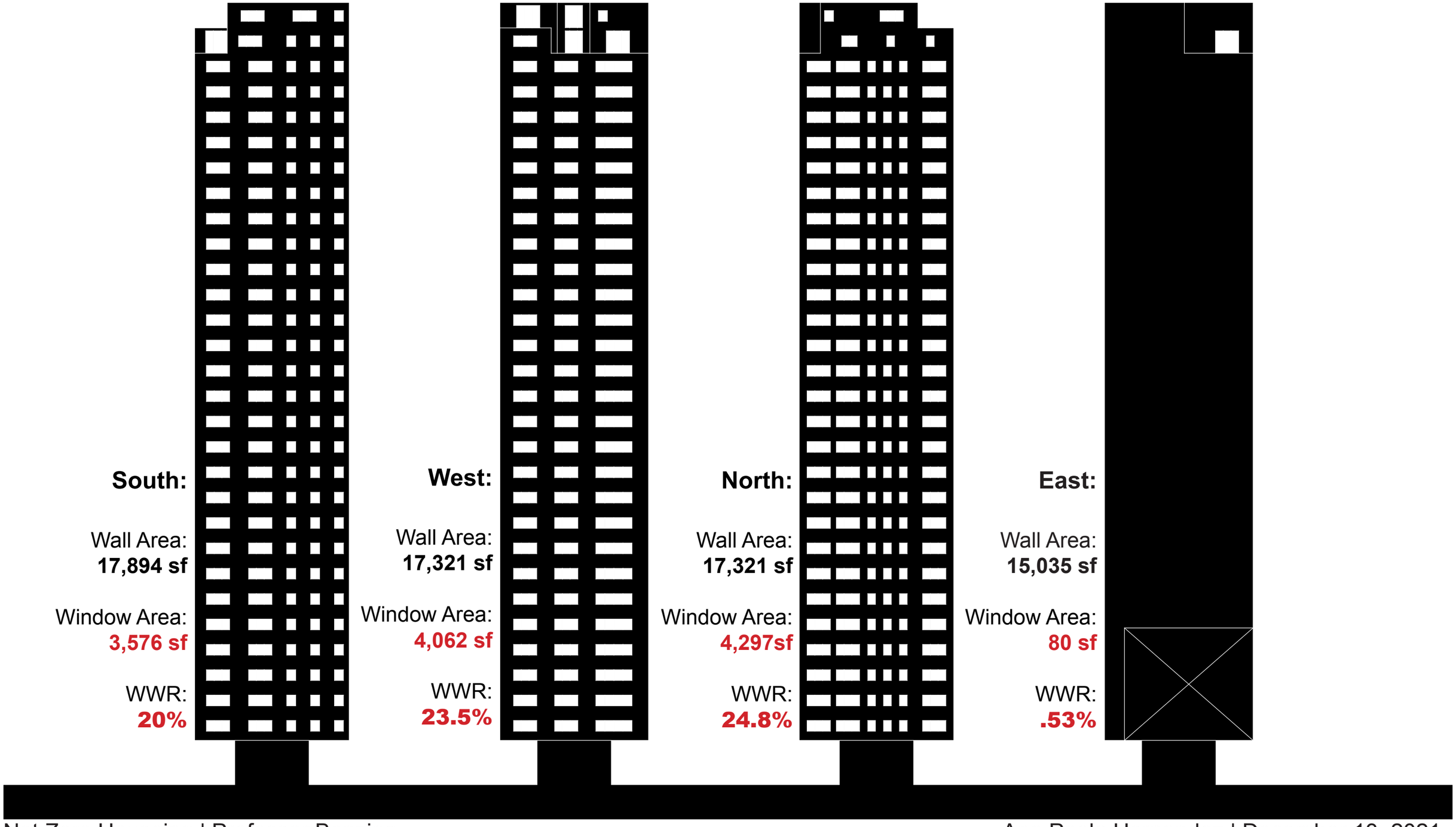


6.2 - Figure & Ground - Solar Analysis

Architectural relations are based on the common laws of physics, but ultimately become truly meaningful only through reference and analogy to the individual`s existence as a human being.”

Karl Friedrich Schinkel, Das Architektonische Lehrbuch

Figure Ground Elevations:
Original Design



South:

Wall Area:
17,894 sf

Window Area:
3,576 sf

WWR:
20%

West:

Wall Area:
17,321 sf

Window Area:
4,062 sf

WWR:
23.5%

North:

Wall Area:
17,321 sf

Window Area:
4,297sf

WWR:
24.8%

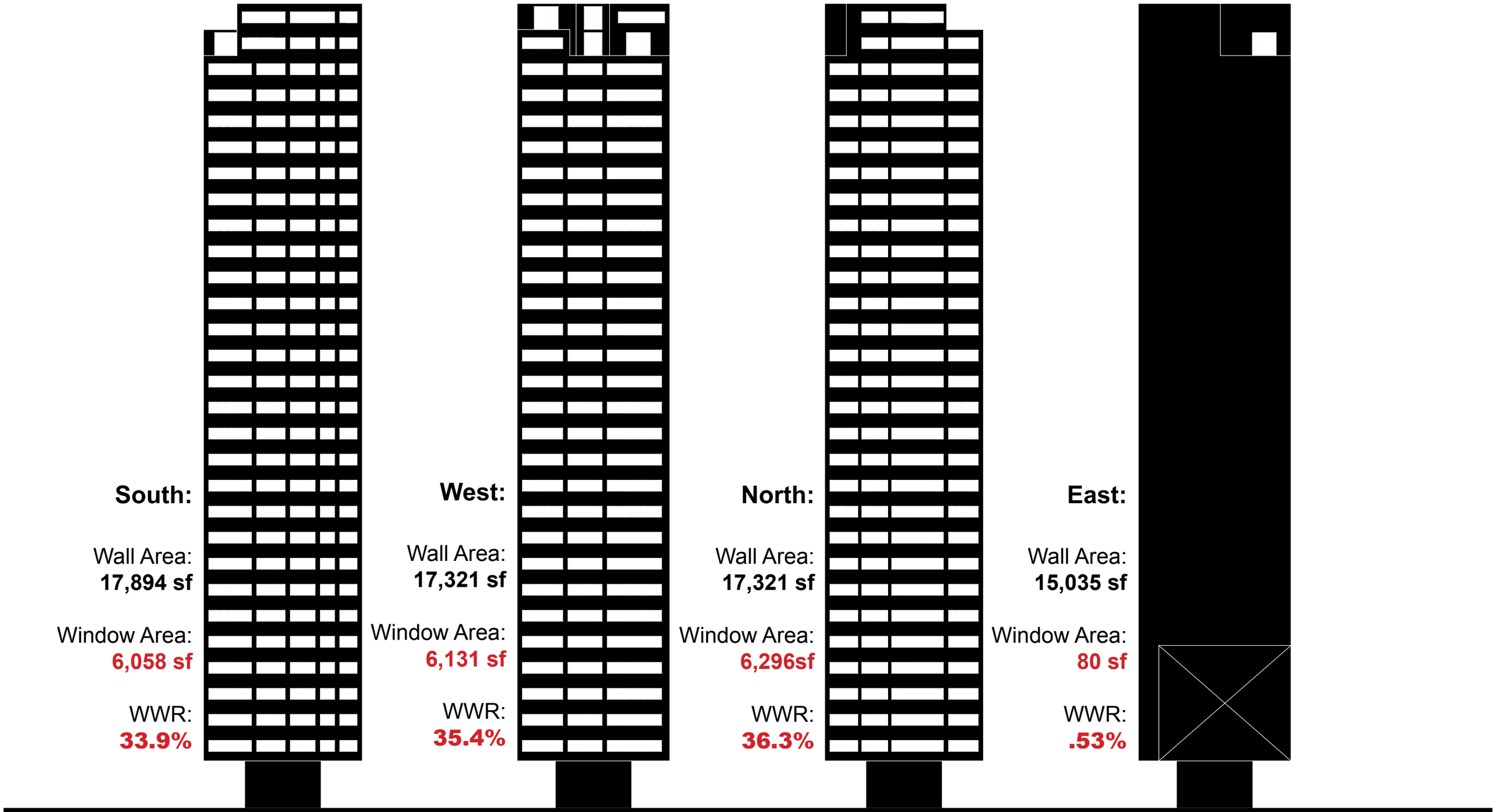
East:

Wall Area:
15,035 sf

Window Area:
80 sf

WWR:
.53%

Figure Ground Elevations:
New Design: Horizantal Windows



South:

Wall Area:
17,894 sf

Window Area:
6,058 sf

WWR:
33.9%

West:

Wall Area:
17,321 sf

Window Area:
6,131 sf

WWR:
35.4%

North:

Wall Area:
17,321 sf

Window Area:
6,296sf

WWR:
36.3%

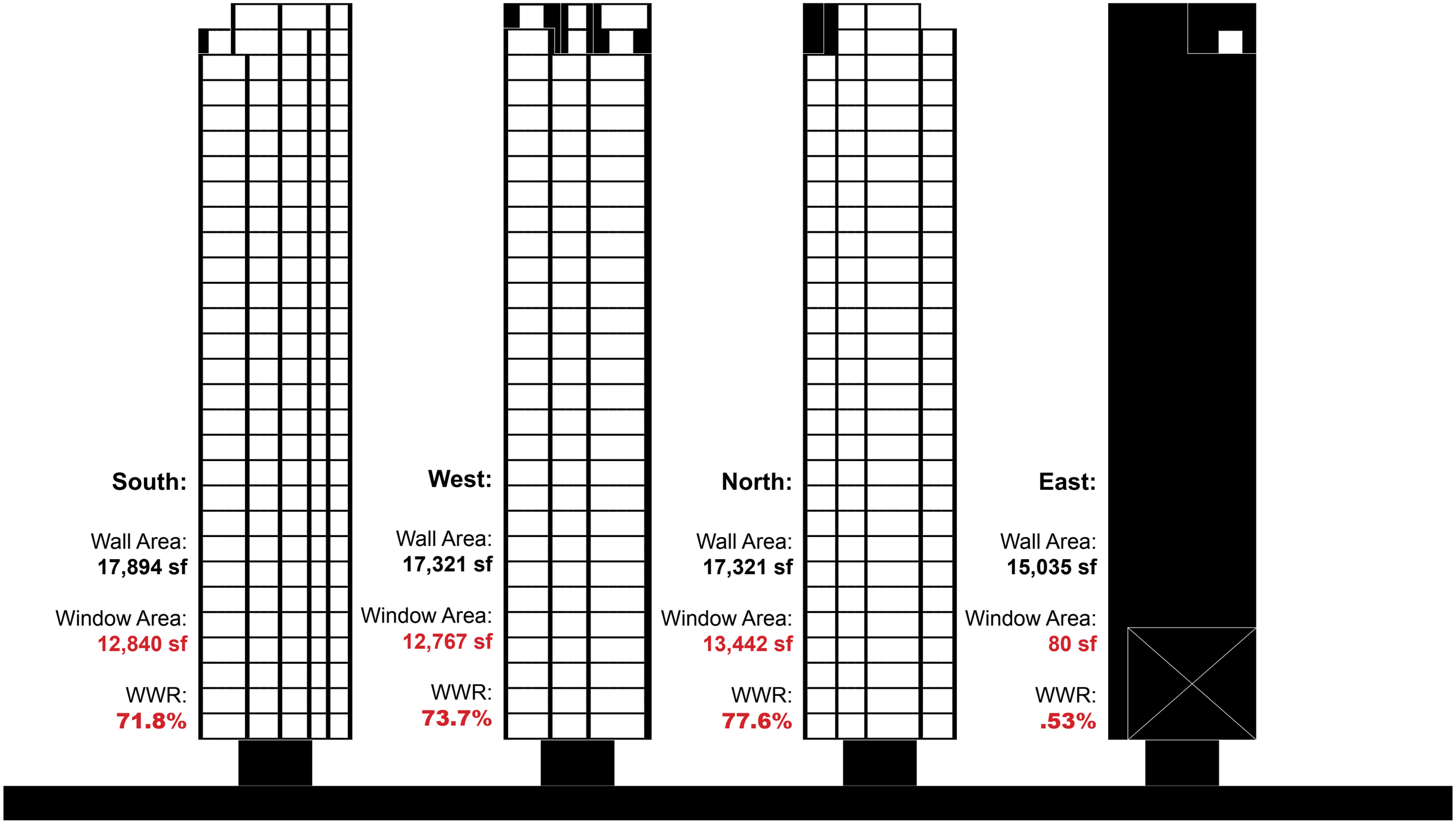
East:

Wall Area:
15,035 sf

Window Area:
80 sf

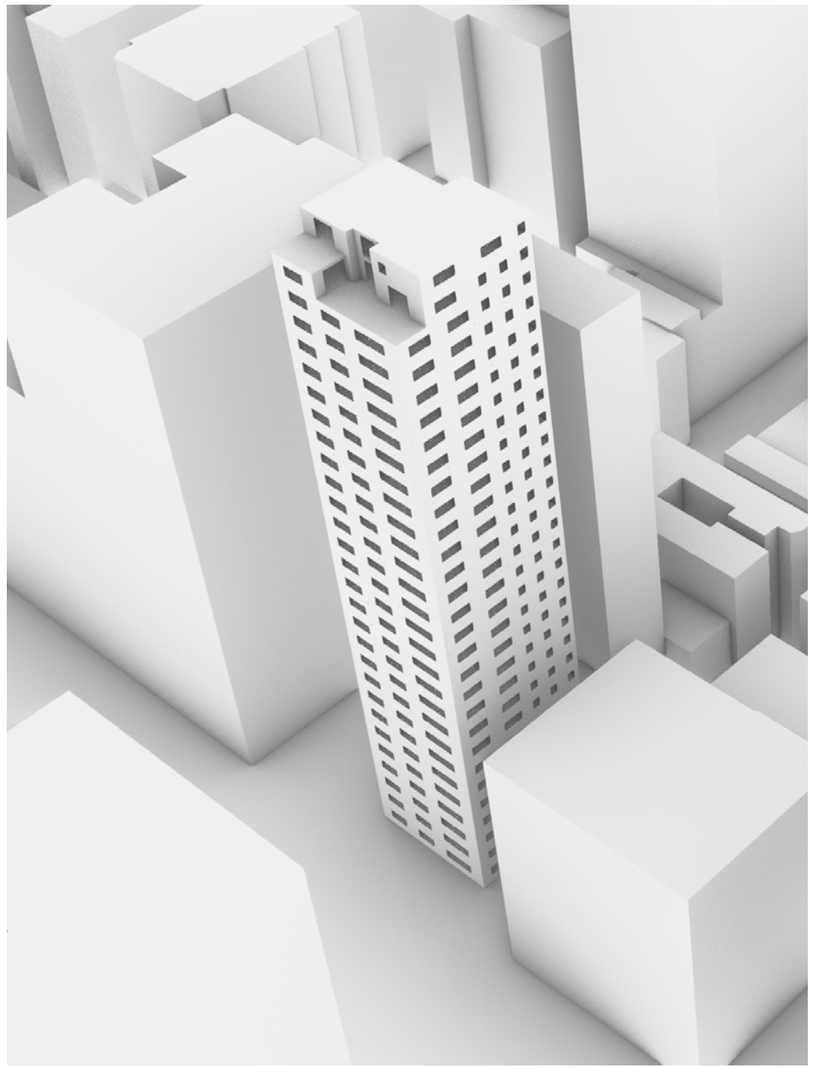
WWR:
.53%

Figure Ground Elevations:
New Design: Floor to Ceiling Windows



Cut-out Models:
Window Comparison

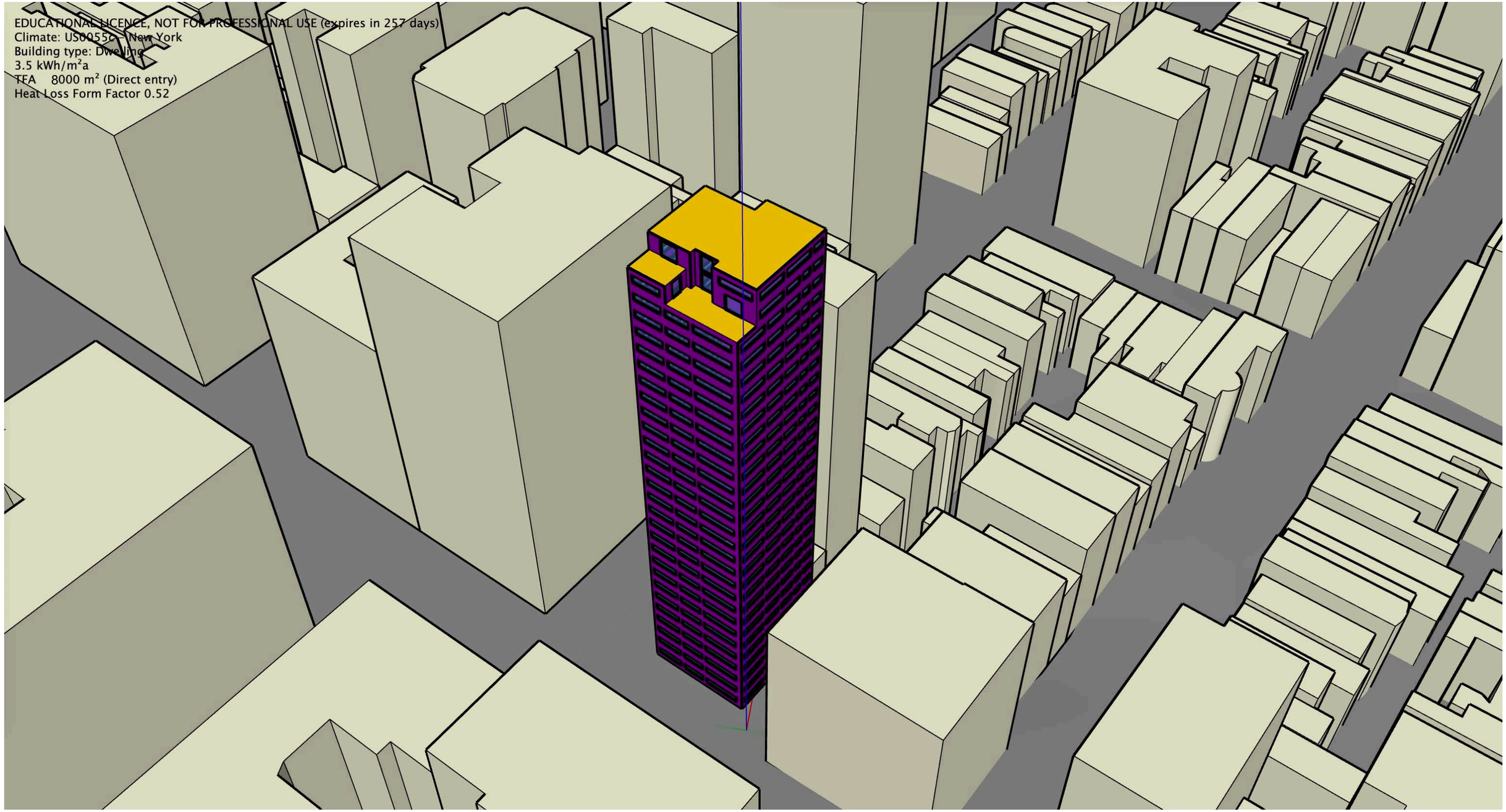
Original Design



Horizontal Windows

Floor to Ceiling Windows

Adjusted Design PH Model:
New Design: Horizantal Windows



Design PH Analysis:
New Design: Horizantal Windows

▾ Heat balance

▾ Project overview

EDUCATIONAL LICENCE, NOT FOR PROFESSIONAL USE (expires in 235 days)

Climate	New York	change
Building type	Dwelling	change
Annual heat demand (Q_h)	5.8 kWh/m²a	details
Treated Floor Area (TFA)	8000 m² (Direct entry)	details
Thermal envelope area	7136 m²	details
Heat Loss Form Factor	0.89	
Projected building footprint	-.-- m²	
Number of windows	344	details
Number of thermal surfaces	22	details
Number of thermal bridges	None defined	details
Render mode	Render by Area Group	

▾ Transmission heat loss (opaque surfaces)

Area group	Total area (m²)	Area weighted U-value (W/m²K)	Av. temp. factor	Transmission heat losses (kWh/a)	Q_t (kWh/m²a)
7 - External Door	0.00				
8 - External Wall - Ambient	5076.23	0.19	1.00	60752.37	7.59
9 - External Wall - Ground	0.00				
10 - Roof/Ceiling - Ambient	337.15	0.38	1.00	8156.26	1.02
11 - Floor slab / Basement ceiling	0.00				
12 -	0.00				
13 -	0.00				
14 - Temperature zone X	0.00				
18 - Partition Wall to Neighbour	212.37	0.25	0.00	0.00	0.00
	5625.75			**68908.63**	**8.61**

▾ Transmission heat loss (windows)

Area group	Total area (m²)	Area weighted U-value (W/m²K)	Av. temp. factor	Transmission heat losses (kWh/a)	Q_t (kWh/m²a)
2 - North Windows	585.02	0.94	1.00	35248.40	4.41
3 - East Windows	7.56	0.46	1.00	221.16	0.03
4 - South Windows	560.48	0.95	1.00	34092.55	4.26
5 - West Windows	569.95	0.53	1.00	19173.56	2.40
6 - Horizontal Windows	0.00				
	1723.01			**88735.66**	**11.09**

▾ Transmission heat loss (thermal bridges)

Area group	Total length (m)	Average Psi-value (W/mK)	Av. temp. factor	Transmission heat losses (kWh/a)	Q_t (kWh/m²a)
15 - Thermal Bridges Ambient	0.00				
16 - Perimeter Thermal Bridges	0.00				
17 - Thermal Bridges Floor Slab / Basement Ceiling	0.00				
	0.00			**0.00**	**0.00**

▾ Ventilation heat losses

	Energy effective air change rate (1/h)	Ventilation volume (m³)	Ventilation heat losses (kWh/a)	Q_v (kWh/m²a)
Ventilation system	0.0451	21600.00	20575.16	2.57
Infiltration	0.0462	21600.00	21076.07	2.63
	0.0913		**41651.24**	**5.21**

▾ Solar heat gains

Area group	Win. area (m²)	Glazing area (m²)	g-value	Reduction factor	Radiation, G_s (kWh/a)	Solar heat gains (kWh/a)	Q_s (kWh/m²a)
2 - North Windows	585.02	426.35	0.50	0.35	136.34	13868.92	1.73
3 - East Windows	7.56	6.10	0.50	0.61	425.49	987.47	0.12
4 - South Windows	560.48	398.78	0.50	0.41	527.84	60162.08	7.52
5 - West Windows	569.95	423.32	0.50	0.38	189.33	20712.86	2.59
6 - Horizontal Windows	0.00	0.00				0.00	0.00
	1723.01	**1254.55**				**95731.33**	**11.97**

▾ Internal heat gains

Treated Floor Area (m²)	Internal heat gain rate (W/m²)	Heating period (days/a)	Heating period (kh/a)	Internal heat gains (kWh/a)	Q_i (kWh/m²a)
8000.00	2.28	175.00	4.20	76440.00	9.56

▾ Ventilation heat losses

Select ventilation type: 1 - Balanced PH ventilation with HR — Select ventilation unit: 02ud - [85.0%] Example: good efficiency HR

Room height, (m)	Air change rate at pressure test, n50 (1/h)
2.7	0.6

Room height, (m)	Treated Floor Area (m²)	Ventilation volume, V_v (m³)	Net air volume for pressure test, V_{n50} (m³)	Air change rate at pressure test, n50 (1/h)
2.70	8000.00	21600.00	23760.00	0.60

Design air flow rate (m³/h)	V_dot_av	Average air change rate (1/h)	Heat recovery efficiency eta_HR_eff	
8424.00	6486.48	0.30	0.85	0.85

▾ Internal heat gains

Building type: Dwelling — Number of units (dwellings only): 28

Internal heat gain rate (W/m²): 2.28

9.2 - Mass & Void - Tectonic Facade

“...his conviction increased that architectural manipulation, as a homely art or a fine art must be rendered completely plastic to the mind and the hand of the designer; that materials and forms must yield to the mastery of his imagination and his will...”

The Autobiography of an Idea, Louis H. Sullivan

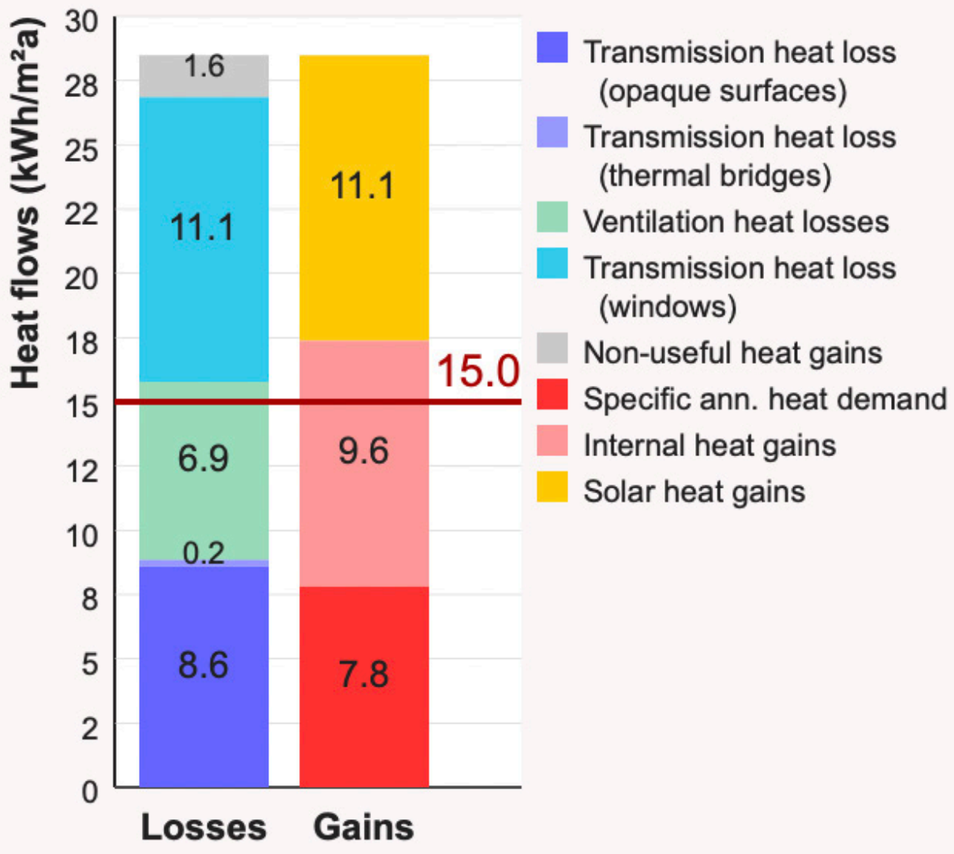
Perspective Street View:
9:00 am

Perspective Street View:
12:00 pm

Perspective Street View:
6:00 pm

Design PH Analysis:
Overall Energy Balance

▼ Heat balance



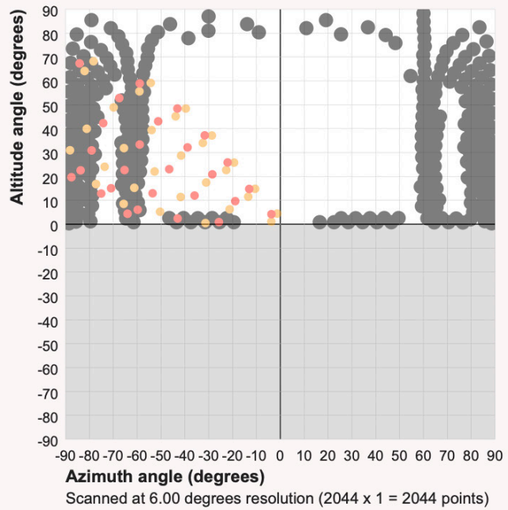
▼ Project overview

EDUCATIONAL LICENCE, NOT FOR PROFESSIONAL USE (expires in 235 days)

Climate	New York	change
Building type	Dwelling	change
Annual heat demand (Q_h)	7.8 kWh/m²a	details
Treated Floor Area (TFA)	8000 m² (Direct entry)	details
Thermal envelope area	7136 m²	details
Heat Loss Form Factor	0.89	
Projected building footprint	-.-- m²	
Number of windows	344	details
Number of thermal surfaces	22	details
Number of thermal bridges	97	details
Render mode	Render by Area Group	

Design PH Analysis:
Tectonic Facade Window Shade Analysis

▾ Shading mask diagram (raster)



Scanned at 6.00 degrees resolution (2044 x 1 = 2044 points)

▾ Analyse single window

Select a single window to analyse using the button below or 'Analyse window shading' from the context menu. Hourly results can be inspected in the tables and charts below.

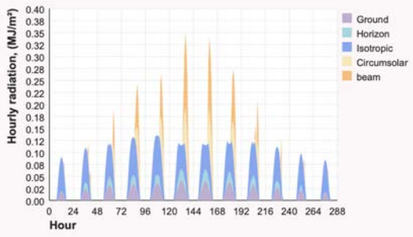
NOTE: The settings below will be used for all windows the next time you run analysis. The energy balance will not be updated until you run analysis.

Analyse selected window | Select: shading mask resolution: Lo-res (30) | Select: number of analysis points: Centre point

Season	Unshaded radiation	Shaded radiation	Shading factor np_reduc
winter	194.4	167.5	0.86
summer	268.5	240.0	0.89

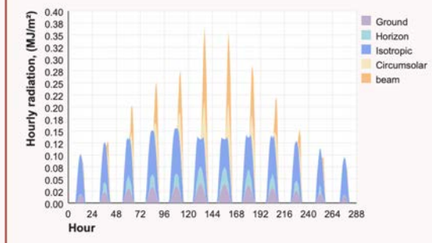
▾ Hourly radiation on slope, shaded

Month: -All-

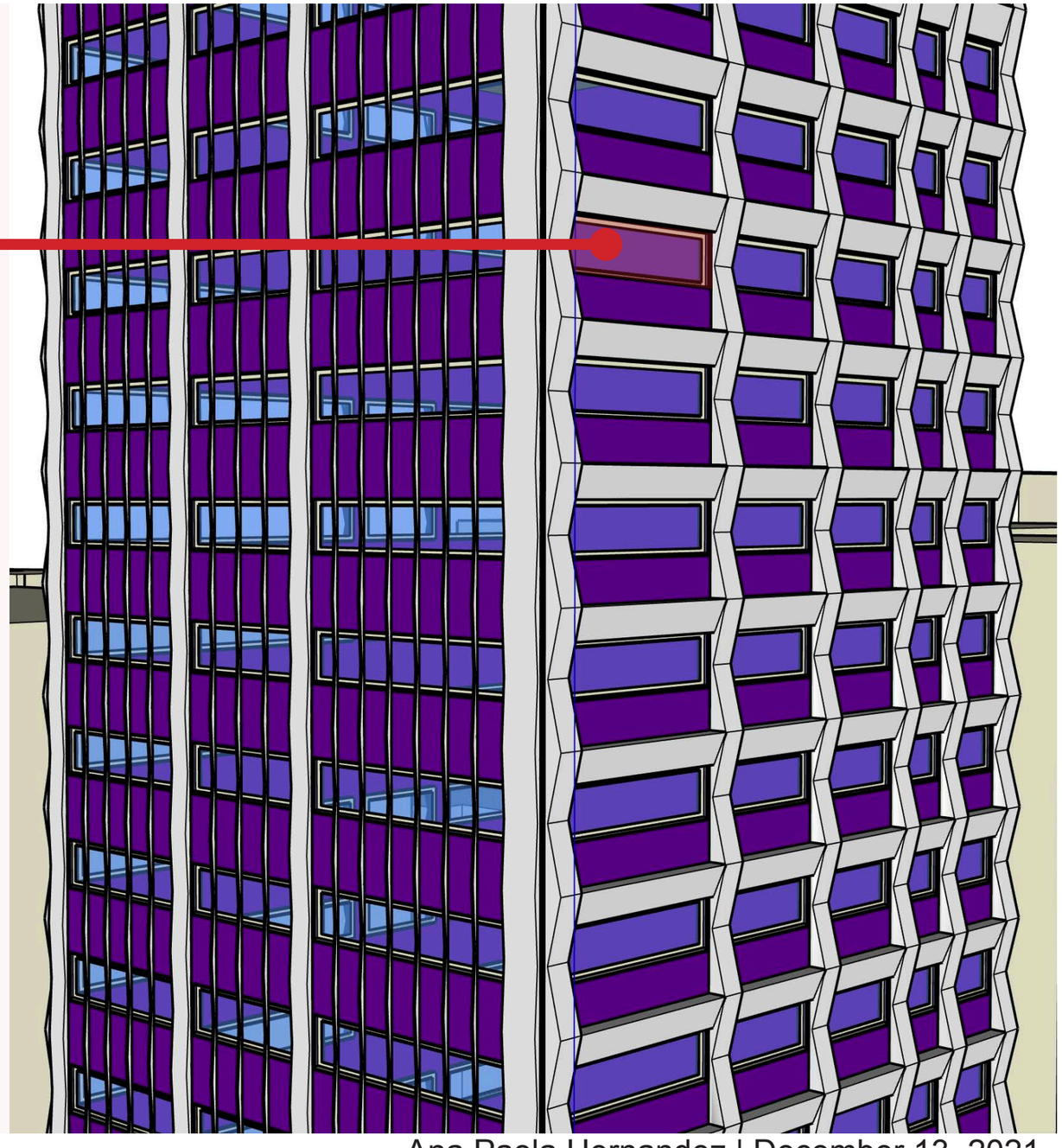


▾ Hourly radiation on slope, unshaded

Month: -All-



Single Window
South Faceing
23 Floor
Living Room



Design PH Analysis:
Detail Analysis

Transmission heat loss (opaque surfaces)

Area group	Total area (m^2)	Area weighted U-value (W/m^2K)	Av. temp. factor	Ann. htg. degree hours (kKh/a)	Transmission heat losses (kWh/a)	Q_t (kWh/m^2a)
7 - External Door	0.00			64.00		
8 - External Wall - Ambient	5076.23	0.19	1.00	64.00	60752.37	7.59
9 - External Wall - Ground	0.00			64.00		
10 - Roof/Ceiling - Ambient	337.15	0.38	1.00	64.00	8156.26	1.02
11 - Floor slab / Basement ceiling	0.00			64.00		
12 -	0.00			64.00		
13 -	0.00			64.00		
14 - Temperature zone X	0.00			64.00		
18 - Partition Wall to Neighbour	212.37	0.25	0.00	64.00	0.00	0.00
	5625.75				**68908.63**	**8.61**

Transmission heat loss (windows)

Area group	Total area (m^2)	Area weighted U-value (W/m^2K)	Av. temp. factor	Ann. htg. degree hours (kKh/a)	Transmission heat losses (kWh/a)	Q_t (kWh/m^2a)
2 - North Windows	585.02	0.94	1.00	64.00	35248.40	4.41
3 - East Windows	7.56	0.46	1.00	64.00	221.16	0.03
4 - South Windows	560.48	0.95	1.00	64.00	34092.55	4.26
5 - West Windows	569.95	0.53	1.00	64.00	19173.56	2.40
6 - Horizontal Windows	0.00			64.00		
	1723.01				**88735.66**	**11.09**

Transmission heat loss (thermal bridges)

Area group	Total length (m)	Average Psi-value (W/mK)	Av. temp. factor	Ann. htg. degree hours (kKh/a)	Transmission heat losses (kWh/a)	Q_t (kWh/m^2a)
15 - Thermal Bridges Ambient	0.00			64.00		
16 - Perimeter Thermal Bridges	1296.14	0.04	0.60	64.00	1990.86	0.25
17 - Thermal Bridges Floor Slab / Basement Ceiling	0.00			64.00		
	1296.14				**1990.86**	**0.25**

Ventilation heat losses

	Energy effective air change rate (1/h)	Ventilation volume (m^3)	Heat capacity of air	Ann. htg. degree hours (kKh/a)	Ventilation heat losses (kWh/a)	Q_v (kWh/m^2a)
Ventilation system	0.0751	21600.00	0.33	64.00	34271.57	4.28
Infiltration	0.0462	21600.00	0.33	64.00	21076.07	2.63
	0.1213				**55347.64**	**6.92**

Solar heat gains

Area group	Win. area (m^2)	Glazing area (m^2)	g-value	Reduction factor	Radiation, G_s (kWh/a)	Solar heat gains (kWh/a)	Q_s (kWh/m^2a)
2 - North Windows	585.02	426.35	0.50	0.31	136.34	12518.11	1.56
3 - East Windows	7.56	6.10	0.50	0.60	425.49	970.58	0.12
4 - South Windows	560.48	398.78	0.50	0.38	527.84	56604.87	7.08
5 - West Windows	569.95	423.32	0.50	0.35	189.33	18737.54	2.34
6 - Horizontal Windows	0.00	0.00				0.00	0.00
	1723.01	**1254.55**				**88831.10**	**11.10**

Internal heat gains

Treated Floor Area (m^2)	Internal heat gain rate (W/m^2)	Heating period (days/a)	Heating period (kh/a)	Internal heat gains (kWh/a)	Q_i (kWh/m^2a)
8000.00	2.28	175.00	4.20	76440.00	**9.56**

Ventilation heat losses

Select ventilation type: 1 - Balanced PH ventilation with HR — Select ventilation unit: 97ud - [75.0%] Default: PH minimum efficiency HR

vent_sys_ID	vent_type_ID	Room height, (m)	Air change rate at pressure test, n50 (1/h)
97ud	1	2.7	0.6

Room height, (m)	Treated Floor Area (m^2)	Ventilation volume, V_v (m^3)	Net air volume for pressure test, V_{n50} (m^3)	Air change rate at pressure test, n50 (1/h)	Wind protection coeff., e	Wind protection coeff., f
2.70	8000.00	21600.00	23760.00	0.60	0.07	15.00

Design air flow rate (m^3/h)	V_dot_av	Average air change rate (1/h)	vent_n	v_ex	Heat recovery efficiency	eta_HR_eff
8424.00	6486.48	0.30	0	0.75	0.75	

Internal heat gains

Building type: Dwelling — Number of units (dwellings only): 28

Internal heat gain rate (W/m^2): 2.28

Glazing (user-defined)

ID	Description	g-value	U-value (W/m^2K)
01ud	PH glazing	0.5	0.8
02ud	South North Glazing	0.5	0.8
03ud	East West Glazing	0.5	0.25
04ud		0.0	0.0
05ud		0.0	0.0
06ud		0.0	0.0
07ud		0.0	0.0

↓ show more... (8 rows hidden) ↓

11.2 - Photovoltaic (PV) Energy Calculation

“Solar Power is not about fashion, it’s about survival”

Sir Norman Foster

Photovoltaic (PV) System:
Renewable Energy Laboratory (NREL) PV Watts Calculator

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Caution: Photovoltaic system performance predictions calculated by PVWatts® include many inherent assumptions and uncertainties and do not reflect variations between PV technologies nor site-specific characteristics except as represented by PVWatts® inputs. For example, PV modules with better performance are not differentiated within PVWatts® from lesser performing modules. Both NREL and private companies provide more sophisticated PV modeling tools (such as the System Advisor Model at https://sam.nrel.gov) that allow for more precise and complex modeling of PV systems.

The expected range is based on 30 years of actual weather data at the given location and is intended to provide an indication of the variation you might see. For more information, please refer to this NREL report: The Error Report.

The energy output range is based on analysis of 30 years of historical weather data for nearby, and is intended to provide an indication of the possible interannual variability in generation for a Fixed (open rack) PV system at this location.

RESULTS

51,375 kWh/Year*

System output may range from 49,315 to 53,096 kWh per year near this location.

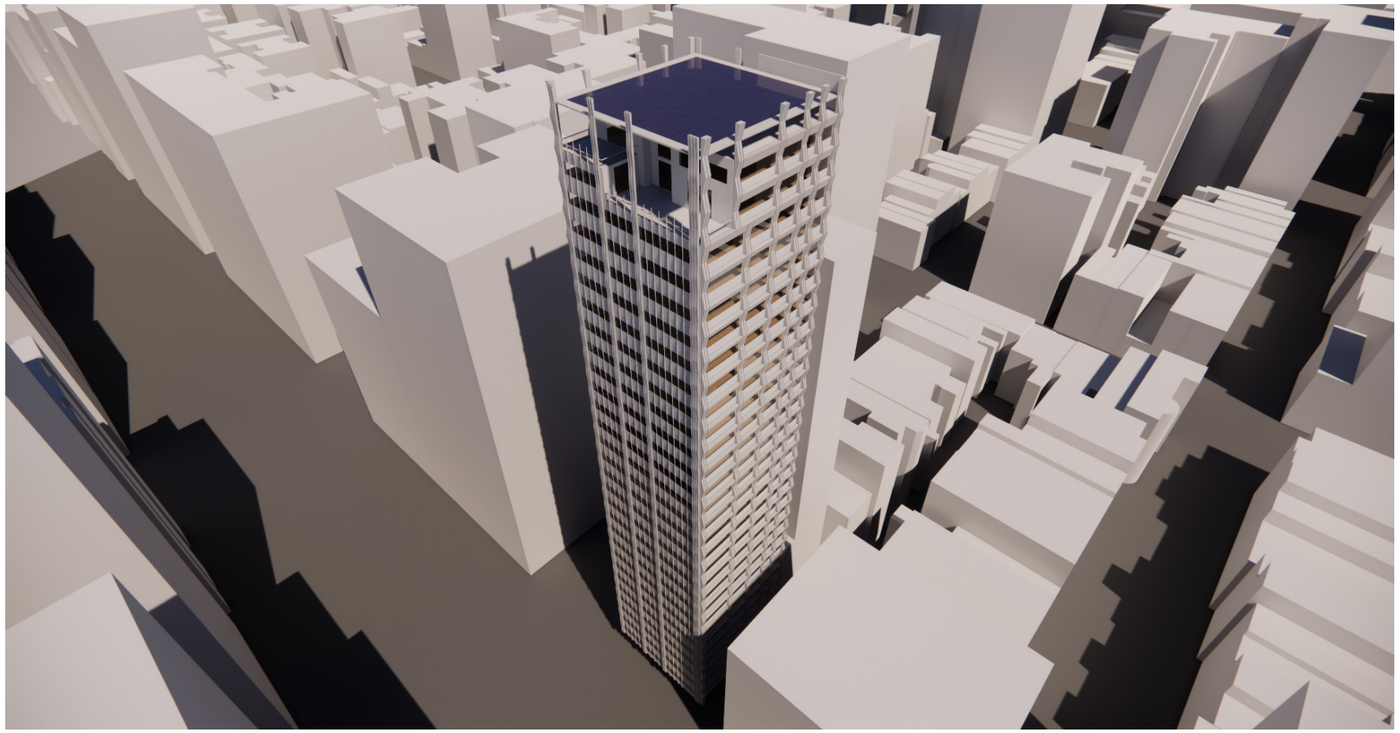
Month	Solar Radiation (kWh / m² / day)	AC Energy (kWh)	Value ($)
January	2.05	2,276	1,138
February	2.86	2,949	1,474
March	4.10	4,685	2,343
April	5.03	5,309	2,655
May	5.48	5,825	2,912
June	6.27	6,287	3,143
July	6.20	6,387	3,193
August	5.43	5,535	2,768
September	4.53	4,516	2,258
October	3.15	3,351	1,676
November	2.25	2,398	1,199
December	1.67	1,858	929
Annual	4.09	51,376	$ 25,688

Location and Station Identification	
Requested Location	733 Park Avenue New York
Weather Data Source	Lat, Lon: 40.77, -73.98 0.8 mi
Latitude	40.77° N
Longitude	73.98° W

PV System Specifications *(Residential)*	
DC System Size	45.2 kW
Module Type	Standard
Array Type	Fixed (open rack)
Array Tilt	0°
Array Azimuth	180°
System Losses	14.08%
Inverter Efficiency	96%
DC to AC Size Ratio	1.2

Economics	
Average Retail Electricity Rate	0.500 $/kWh

Performance Metrics	
Capacity Factor	13.0%



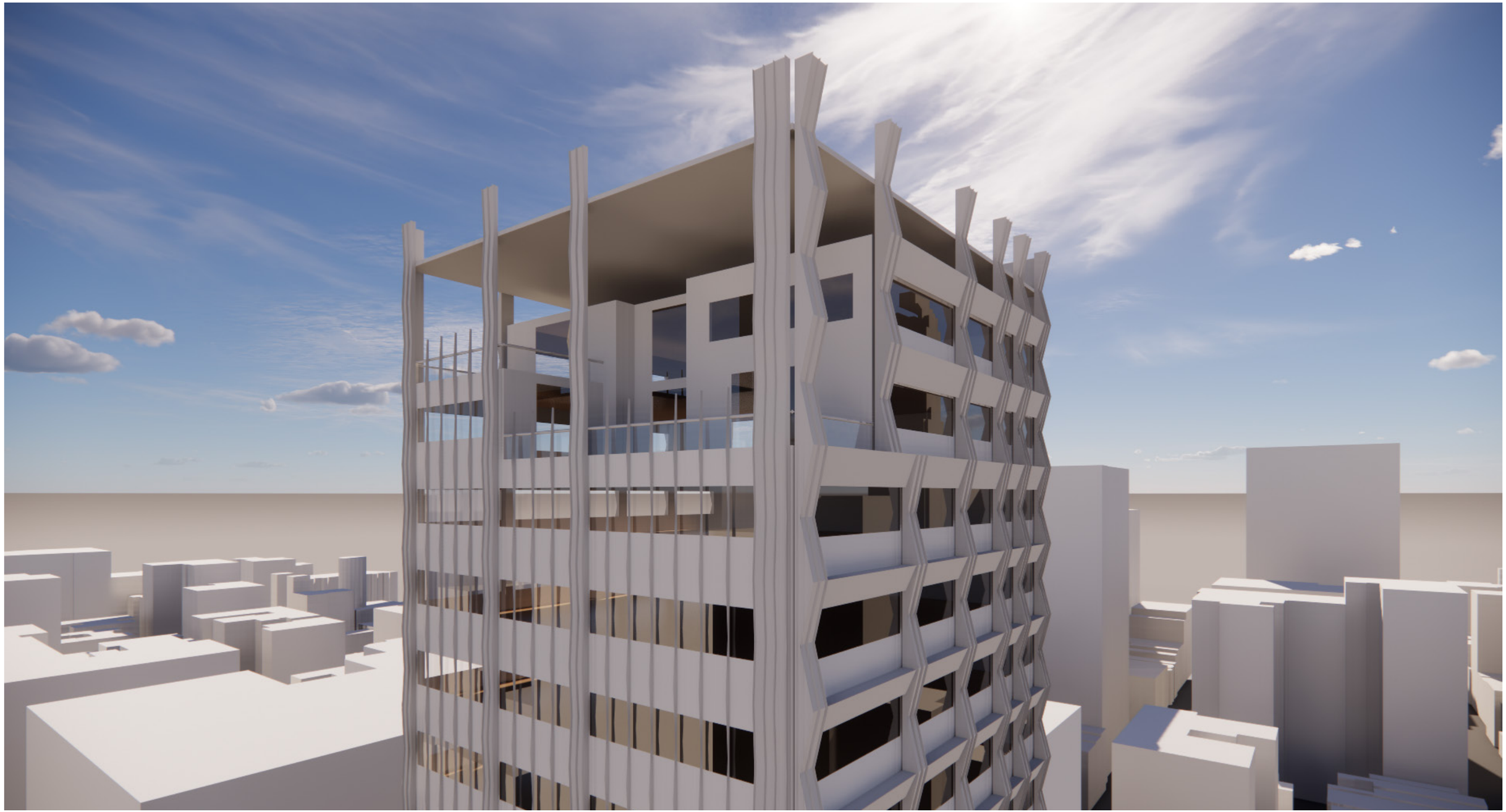
Annual Electric Energy: **51,375 kWh/Year**
Overall Floor Area of Building: **÷ 8,000 m²**
= 6.4 kWh per year ft²

Design PH Annual Heat Demand: **7.8 kWh/m²a**

PV systems delivery of the annual heating demand

= 82%

Crown and Techtonic Facade:



Final Perspective Streel View: